Power Generation and POWER PLANT ENGINEERING

For ALL Power Engineers • Steam, Electricity and All Other Power Engineering Services

COMPLETE CONTENTS

★ **The Greens Bayou Station of Houston Lighting and Power Co.** 54
By Louis Elliott

New Diesel Plant Saves $10,000 in First 4 Months' Operation 59

Central Control Rooms—Design & Operation 62
By B. F. Bergel

★ **The Cyclone Furnace—Latest Thing in Coal Burning** 64
By F. X. Gilg

Refining and Production of Fuel Oils 71
By Paul F. Schmidt

Power Generation News Reel 72

★ **Don't Underestimate Cables and Potheads** 74
By H. H. Ackmann

First 5000-kw Packaged Turbine Generator Simplifies Installation 80
By A. A. Woodward and R. R. Kaley

Power Usage Diagram Shows Steam Turbine's Part in Pulp Production 82

Can "The Glamor Girl"—the Spreader Stoker—Fire Large Boilers? 84
By J. S. Bennett and F. C. Messores

Large Electronic D-C Motor Drives in Industry 86

Basic Power Plant Figuring 88
By William H. Engelman

The Honor of Dignified Willy 92
By John Raven

New Steam Generating Plant Serves Columbia Steel's New Cold-Reduction Mill 102

Steam Sampling Methods 104

Babcock & Wilcox Installs New Laboratory 106

NH_3 Liquid Level Control Increases Compressor Capacity and Improves Plant Operation 108

How Waste Heat Recovery Saves Btu's For Schramm 110

New Full Wave Reversing Educational Thy-Mo-Trol Drive Announced by G. E. 110

Regular Departments

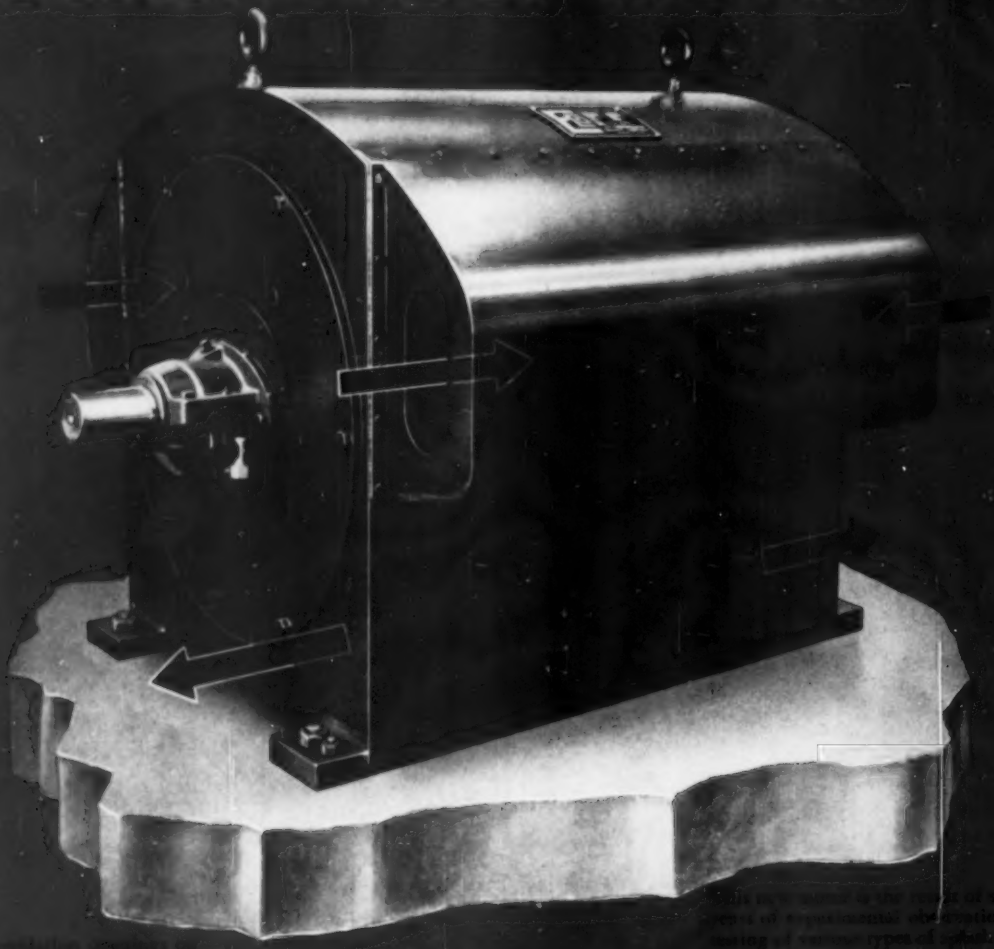
Notes On This Issue 5
Engineers' Preview 7
Helpful Bulletins 35
New Equipment News 42
Construction News 50
Letters to the Editors 53
Fisk Operator Liked It
Boiler Horsepower
Filter Paper
The Grounded Neutral in the East

Questions and Answers 96
How Often Should Standby Diesels Be Run?
Wants Electromagnet to Remove Steel Shot From Boiler Headers
Why Do Thrust Bearings Wear Out?
New Engineering Books 96
Coming Events 108
News from the Field 114
Obituaries 120
Catalog Library 122

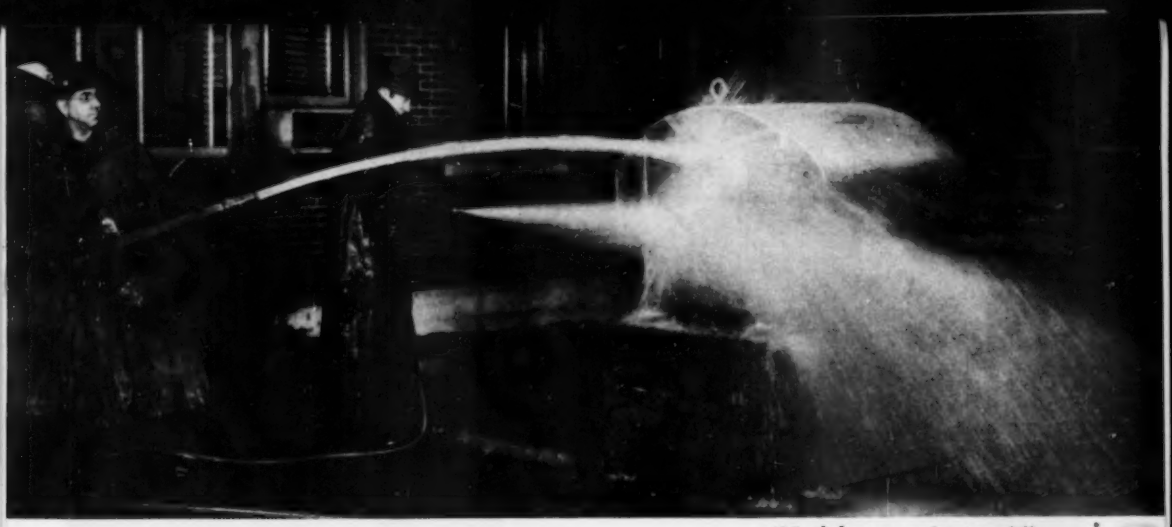
APRIL 1950

ELLIOTT FABRI-STEEL

SPLASH-PROOF MOTOR



IN MOTORS, IT'S ELLIOTT *all*



"A deluge can't stop it"

- Protected from all directions against wind-driven rain.
- Wind-driven foreign matter blows straight through inlets and outlets without entering motor.
- Inlets and outlets baffled internally—air taken into motor at low velocity.
- Screens or filters may be added to inlets.
- Sealed split ring-oiled sleeve bearings or antifriction bearings.
- Stator coils with mica wrapper on slot portion for 2300-volt and higher class "A" insulation.
- Stator coils are vacuum-pressure impregnated.
- Stator and coils after winding given one complete dip and bake, and end turns two additional dips and bakes.
- Foundation may be a simple, economical slab. Does not need to be special or have expensive cored openings.
- No objectional air recirculation.
- All steel frame and brackets coated inside and out with rust inhibiting finish.

Built in sizes 150 to 2000 hp, 4 to 14 poles.

Contact nearest Elliott Company District Office for details.

L-800

ELLIOTT COMPANY

RIDGWAY DIVISION, RIDGWAY, PA.

Plants at: JEANNETTE, Pa., RIDGWAY, PA. AMPERE, N. J., SPRINGFIELD, O., NEWARK, N. J.

DISTRICT AND BRANCH OFFICES

Atlanta 3	310 Haas-Howell Bldg.
Boston 10	75 Federal Street
Buffalo 2	807 Crosby Building
Chicago 6	20 N. Wacker Drive
Cincinnati 2	1218 Enquirer Bldg.
Cleveland 14	Nat'l City Bank Bldg.
Denver 16	4949 Colorado Blvd.
Detroit 26	1820 Dime Bank Bldg.
Houston 2	713 M & M Building
Kansas City 6	805 Midland Building
Los Angeles 15	714 W. Olympic Blvd.
Milwaukee	744 N. 4th Street
Minneapolis 2	830 Pillsbury Building
Newark	4th Avenue and 13th Street
New York 7	225 Broadway
Philadelphia 2	801 Morris Bldg.
Pittsburgh 19	718 Frick Building
San Francisco 4	1504 Russ Bldg.
St. Louis 3	1221 Locust Street
Seattle 1	1101 Vance Building
Tulsa 3	616 McBirney Building
Washington 1, D. C.	1101 Washington Gas Light Bldg.
Wilmington 7	Industrial Trust Building

Representatives in Foreign Offices

the way from 1 hp up . . .

"This Steam Trap is unconditionally guaranteed to satisfy you!"

YOU CAN'T LOSE

SAVED 3728 GALLONS OF FUEL OIL in one year after replacing old traps with Armstrongs on kettles, low pressure heating system and cream beaters.—*Mary Lincoln Candies, Buffalo, New York.*

30% LESS MAINTENANCE with Armstrong traps on heating and steam distribution system.—*John Deere Harvester Works, East Moline, Ill.*

COOKING KETTLE OUTPUT SPEEDED UP 30% by Armstrong trapping on each steam jacketed kettle.—*Bulman's Ltd., Vernon, B. C.*

EVERY Armstrong steam trap is guaranteed to be free from defective workmanship or material, to function perfectly, to fulfill all claims in every respect and to give complete satisfaction.

ONLY A GOOD STEAM TRAP COULD *POSSIBLY* BE BACKED BY SUCH A GUARANTEE! To save fuel, to reduce maintenance, to get more work out of existing equipment, to get complete steam trap satisfaction, ask your nearby Armstrong representative to discuss with you the traps you need now.

ARMSTRONG MACHINE WORKS
810 Maple St., Three Rivers, Mich.

SEND FOR YOUR COPY OF THE 36-PAGE ARMSTRONG STEAM TRAP BOOK explaining the design and workmanship that make the Armstrong guarantee possible. Complete data on the selection and installation of traps for all classes of equipment. Free on request.

SEE OUR CATALOG IN SWEET'S FILE

ARMSTRONG STEAM TRAPS

EDITORIAL STAFF
ANDREW W. KRAMER
Editor
CHESTER R. EARLE
Managing Editor
THOMAS E. HANSON
Associate Editor
EARL R. NOREN
Assistant Editor
RALPH E. TURNER
Consulting Editor
RICHARD H. MORRIS
Contributing Editor
MARIAN E. HENIKEN
Equipment Editor

Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

KINGSLEY L. RICE, *President*
EDWIN C. PROUTY, *Vice President*
WALTER PAINTER, *Vice President*
ARTHUR L. RICE, JR., *Treasurer*
CHARLES S. CLARKE, *Secretary*
RALPH E. TURNER, *Editorial Advisor*
JOHN O. AARVOLD, *Prod. Manager*

RICHARD M. WARD
Vice President in Charge of Sales

DISTRICT MANAGERS
CHICAGO: Arthur L. Rice, Jr.
John R. Morrison
53 W. Jackson Blvd., Chicago 4, Ill.
Phone: HArrison 7-0824

NEW YORK: Oscar Wilda
George L. Wright, Jr.
860 Graybar Bldg., New York 17, N. Y.
Phone: Murray Hill 5-3779

PHILADELPHIA: Oscar Wilda
216 Jericho Road, Abington, Pa.
Phone: Ogontz 7261W

CLEVELAND: John R. Morrison
681 Union Commerce Bldg.
Cleveland 14, Ohio
Phone: Cherry 1377

PACIFIC COAST: McDonald-Thompson
Roy M. McDonald, Mgr.
564 Market St.
San Francisco 4, Calif.
Phone: Yukon 6-0503

Edwin T. Thompson
639 So. Wilton Place
Los Angeles 5, Calif.
Phone: Dunkirk 7-2590

Harry Abney, Mgr.
Terminal Sales Bldg.
Seattle 1, Wash.
Phone: Main 3860

SOUTHWEST: McDonald-Thompson
Clinton R. Julian
1414 Electric Bldg.
Fort Worth 2, Texas
Phone: 3-9122

Subscription Information—Published Monthly. Prices: United States and Possessions one year $10.00, Canada one year $11.00. Other countries one year $12.00. Single copies $1.00. Changes of address should give both old and new address and reach us by 15th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Contents of back issues of Power Plant Engineering and Power Generation will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

Copyright 1950 by Technical Publishing Company.

Acceptance under Section 34.64, P. L. & R., authorized by United States Post Office.

ABC

Power Generation

April 1950

VOLUME 54—NUMBER 4

Notes on This Issue

The Greens Bayou Outdoor Station

No trend in the design of power stations has been more fundamental or of greater interest than the trend toward the outdoor type of plant. The first outdoor type of construction was experimental in nature; aside from the fact that there was little power plant equipment available that could be adapted to outdoor service, the outdoor idea met with a great deal of prejudice and opposition.

In time, however, the advantage of the outdoor installation became more apparent and manufacturers began to design equipment that was especially suited to outdoor operation.

The Greens Bayou Station at Houston, Texas, is the most completely outdoor power station in the world. With the exception of the main control room, everything else is out in the open, exposed to the weather.

Written by Louis Elliott himself, perhaps the most noted authority on outdoor plant design in this country, this article covers not only the design of this particular station but the philosophy behind the development of the Houston Lighting and Power System as well.

Central Control Rooms

Here is another article on the very timely and important subject of centralized power plant control—more or less of a follow-up to the article by Mr. Mallory in the March issue. In this article, however, Mr. Bogel analyzes the specific use of a centralized control room for the first time by a well-known utility. As a result of its satisfactory experience with this first central control room on its system, this company proposes certain very interesting and in some cases very advanced improvements in the details of any future centralized control rooms it may build.

Discussion of centralized control, such as this one and the one in the March issue, comes to a head now primarily because the various plants that have been testing out these ideas have only recently gone into operation. The ideas themselves have been talked about in various ways for a long time by designers and operating men. But now, since many of them are actually working out well in practice, they will influence the design of controls very materially in the future—in fact, they are already doing so.

Can the Spreader Stoker Fire Large Boilers?

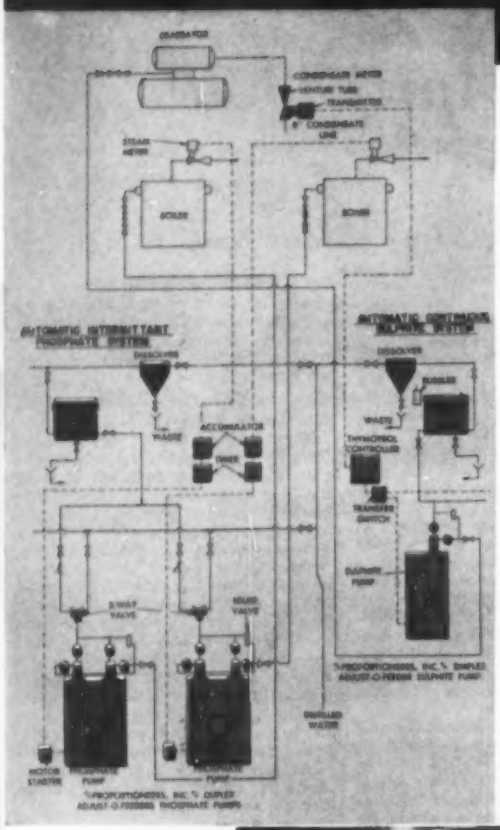
The spreader stoker has risen to favor so rapidly in the field during the past few years that as a purely technical matter it is of interest to everybody to know its limits of capacity.

The principal point of this article, however, is that by various methods, without going beyond the bounds of proved, accepted coal burning practice and the present construction of spreader stokers, we can, by various ingenious methods, enable them to burn a great deal more coal in a given size of furnace and thus permit the firing of boilers by spreader stokers in capacities as high as 500,000 lb an hr capacity. In short, not only does the spreader stoker itself have a great deal of flexibility, but this discussion shows how it also adapts itself to new arrangements that deserve a trial.

The Cyclone Furnace

For many months now, power engineers have been hearing of reports about the new cyclone furnace and have been asking us all sorts of questions about it. "How does it work? What does it look like? What's the advantage of it? Can I use it on my boilers? How small a boiler unit will it fit on? Why and how does it reduce the size of a steam generating unit and the cost of cleaning and maintaining it? How do they get by without dust collectors?" And so on and on.

To answer these and many other questions, we thought it was about time to have a summing up of the present status of the cyclone furnace—and here it is. It should help all power engineers, whether in utility or industrial plants, to judge where the device stands now and where it's going from here. It should also give you all the basic information you need if and when somebody asks you the $64 question: "Can we use it in this plant to help us cut our steam and power costs with the coal we can get?"



BOILER WATER CONDITIONING

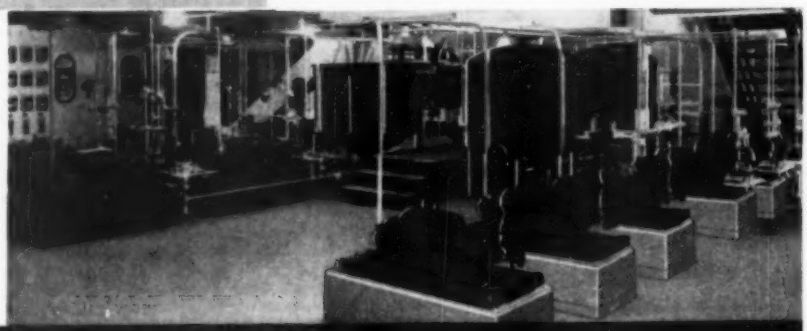
%Proportioneers% boiler water treating equipment was selected for the new Redondo Steam Station of Southern California Edison Co. built by Stone & Webster Engineering Corporation in collaboration with Edison engineers. In this, one of the most modern plants in the world, the boilers are treated automatically and in proportion to their service load. The complete %Proportioneers% system makes chemical treatment a routine procedure, reducing operator responsibility. A necessity in large plants, the %Proportioneers% system is also highly desirable in small plants to reduce manpower and give adequate protection.

We furnish complete feeding systems to engineers' specifications or, where required, can adapt our controls to existing equipment. Ask for Brochure SM 122 "Treatment of Water for Boilers".

All equipment shown red in photo and flow-gram furnished by %Proportioneers, Inc.%

%Proportioneers% sulphite feed pumps in the Redondo Steam Station, in foreground; high pressure duplex phosphate pumps and control panel, in the background.

No. 3 in a series on boiler water conditioning.



% PROPORTIONEERS, INC. %

Write to %Proportioneers, Inc.%, 46 Codding St., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

ENGINEERS' PREVIEW

USE OF THE SUN'S ENERGY to clear ice-locked rivers and lakes is being studied by scientists at Armour Research Foundation in co-operation with the U. S. Coast Guard. They are starting from the fact that a black coating of powder or liquid on ice can make it melt faster in the sun.

★ ★ ★

NEW ENGLAND'S hope that a steel mill might be located there in the near future appeared to be fading as a result of recent decisions by U. S. Steel Corp. In a statement issued January 24, 1950, Benjamin F. Fairless, president of U. S. Steel Corp., states that "after a careful consideration of raw materials and markets in relations to plant locations, we have concluded that, if and when United States Steel Corp. constructs an integrated steel plant on the Atlantic seaboard, it should be located in the Philadelphia-Trenton-New York area. With this possibility in mind, U. S. Steel has recently acquired an acreage on the Delaware River near Morrisville, Pa., about 30 miles northeast of Philadelphia."

Another development in the steel industry is that the mystery of the Berks County land boom has been solved, according to the AP. Bethlehem Steel Co. has announced purchase of land about 50 miles from Bethlehem's main plant and home offices near Morgantown, Pa. This was the site of some of the nation's first iron mines and iron furnaces in the days of the Revolutionary War. Bethlehem Steel has stated that it is interested in prospecting in this area for possible deposits of ore and is a continuation of a general program of prospecting in the vicinity of former workings in this area.

Finally, in a recent statement before the Joint Committee on the Economic Report, U. S. Steel for the first time told the story of its important discovery in 1948 of an immense iron ore deposit in a then unexplored part of Venezuela.

In short, the steel industry is fully aware of the present heavy drain on the Lake Superior high grade iron ore reserves and is doing everything it can to locate new ore resources. All this activity is of extreme importance to power engineers, as users of heavy steel equipment, for it will obviously affect, in one way or another, all the supply and cost factors in steel in the future.

★ ★ ★

THERE OUGHT to be applications in the power plant for the new GE marine shaft-horsepower-hour meter. This meter, developed primarily for marine work, indicates both the power being transmitted to the propellers at any instant and the total energy expended over a period of time. The energy measurement is in horsepower hours and is stated to be accurate within two per cent. The instrument measures the speed of the shaft and the amount of twisting to which the shaft is subjected (torque). The product of these two quantities, calculated automatically, gives the horsepower and, multiplied by time, the total energy.

A similar method is used by Allis-Chalmers in its new pump test floor for measuring the power input to a pump under test, by measuring the shaft speed and measuring the torque on the shaft by means of SR-4 strain gage devices.

"LET US START with the phrase we have heard so often for 16 years: 'We Must Increase Purchasing Power.' So we proceed to increase wages in order to increase purchasing power. I saw a National Industrial Conference Board chart the other day. There were two significant lines. One pictured the increase in the hourly wages of labor since 1945. That line almost went through the top of the chart. The second line pictured the course of the purchasing power of those wages, also since 1945. That line was almost horizontal. In other words, from the point of view of purchasing power, labor is at about the point from which it started four years ago.

"To put it briefly, all the strikes, all the conflict and suffering, all the loss of production and wages, have accomplished only one thing: namely, to prove that purchasing power is production, not dollars." Henry S. Sturgis, *Central Manufacturing District Magazine.*

★ ★ ★

FORMER CHEMICAL "ORPHAN" promises an abundant new source of rocket fuel. The "orphan" is called nitrogen tetroxide. This substance has been well known and the subject of laboratory experimentation for over 75 years, but has only recently lost its "orphan" status as it became readily available at low cost. It gives promise of use as an oxidizer in rockets, which must carry their own oxygen supply to fire other propellants such as gasoline and alcohol.

★ ★ ★

TO DETERMINE when a machine is economically dead and due for replacement, a new guide was advanced recently by the Machinery and Allied Products Institute after more than three years of research by George Terborgh, Institute research director, and a group of equipment manufacturers.

A "replacement formula" is presented, with practical instructions for its applications in an industrial company, in a 75-page "MAPI Replacement Manual," published by the Institute. The formula measures the imperfection of performance of the machine in use in relation to the best alternative available.

"While technology and managerial techniques in most fields have made tremendous progress, the technique of determining when to replace equipment is as unscientific in most cases in 1950 as it was a hundred years ago," says William J. Kelly, president of the Institute. "The 'hunch' and 'rule of thumb' which guide most equipment replacement are nothing but specimens of industrial folklore handed down from one generation of managers to another.

"It is a popular illusion," says Mr. Kelly, "that replacement analysis is something any mechanically-minded individual can do. On the contrary, it is a difficult art calling for special training and experience. It should therefore be in the hands of specialists.

"No live industry can keep abreast of technology without continuous renewal and transformation of its productive facilities. Existing equipment must be kept on the defensive, compelled always to justify its tenure against the challenge of currently available alternatives. If it fails to meet this challenge, it must be displaced regardless of its age or condition, regardless, therefore, of whether it is physically worn out.

"A re-equipment policy that fails to give full recognition to obsolescence is bound to lead to bad mechanization and inefficiency."

IMPORTANT DEVELOPMENT in recent years in lubricating high-speed, high-temperature and high-pressure bearings has been the use of molybdenum in place of, or supplementing, regular lubricating oils and greases. Molybdenum is an extremely "greasy" metal, practically indestructible at high temperatures and pressures, certain forms of it having the peculiar faculty of "plating" itself firmly to any friction surface. This forms a permanent friction-suporting film, which cannot be "squeezed out" by any amount of pressure, thus protecting the bearing against scoring or seizing even after all the oil has been burned out.

Molybdenum lubrication has now been made available in a form suitable for use in any conventional lubricating system, by a new development of the Lubricants Division of The Lockrey Co., which is now placing on the market a new molybdenum-base lubricant called "Liqui-Moly." This can be used alone, or added directly to crank-case or other oils which carry it to the friction-surfaces, where it "plates out" on the metal, providing a permanent low-friction anti-seizing coating. Actual tests have shown that friction-surfaces running at high speed and under heavy pressure will heat up from 300 per cent to 504 per cent faster with ordinary lubricating oil than when running dry with only "Liqui-Moly," and moreover that the temperature-rise with oil is continuous until failure and seizure, whereas with "Liqui-Moly" it reaches a stabilization-point and then usually recedes.

★ ★ ★

AIR CONDITIONING PROBLEMS 100 YEARS AGO, as reported in the New York *Tribune*. "If they would bore a couple of pretty good-sized auger-holes in the top of each omnibus and railroad-car, with others to correspond in the bottom, something would be effected toward ventilation. Now, the amount of carbonic acid and tobacco-gin gas, which every rider is obliged to keep passing in and out of his lungs, is almost as murderous as firedamp."

★ ★ ★

LARGEST CIRCULAR PHOTOGRAPHIC PLATES (70 dozen of them) ever used by astronomers are being rushed to completion by Eastman Kodak research scientists. They are infra-red-and-blue sensitive plates for use on the "Hub of the Universe" expedition of Harvard University astronomers sailing for South Africa this month. This team of astronomers will use the plates in a new type of telescope and the world's largest objective prism to study more than 1,000,000 stars and other interstellar bodies in the Milky Way.

Incidentally, it is pointed out by William F. Swann of EK Company, in the first issue of the new magazine *Photographic Science and Technique*, published by the Photographic Society of America, that photography in industry accounts for more than two-thirds of the photographic materials used today. Photography, maintains Mr. Swann, has become a precise science as dependable as other physical sciences, such as chemistry and physics. Photographs can give an accurate estimate, for example, of the volume of pulp wood in stock piles. Photographs record the tracks of highly ionized particles in the field of nuclear physics. Micro-filming, stress analysis, photomicrography, infrared photography, fluorescent photography and high-speed photography are other industrial aids. A relatively new instrument, the electron miscroscope, is capable of 20,000 times magnification and has important uses in studies of abrasive materials, chemicals, plastics and structures of metals.

THE AMERICAN STANDARD Safety Code for Manlifts, ASA A90.1-1949, was approved as an American standard on December 20, 1949. This code was the result of a project initiated by the Safety Code Correlating Committee of the ASA, and is sponsored jointly by the Association of Casualty and Surety Companies and the American Society of Mechanical Engineers. Interested readers may obtain copies of this Code by writing to the American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.

★ ★ ★

SMALL 20-HP GAS TURBINE in which important parts are made of kentanium, a heat-resistant material recently put on the market, is now under development by Kennametal, Inc. Kentanium has high resistance to oxidation and unusually great strength at high temperatures, it is claimed, withstands thermal shock and has less weight than other heat-resistant materials, hence it becomes feasible to operate it at 2200 F.

★ ★ ★

AGGRESSIVE SALESMANSHIP on the part of the electric utilities is needed to meet the growing reserves in power-producing capacity, according to C. H. Lang, vice president and manager of sales of G.E.'s Apparatus Department. Speaking before the Missouri Valley Power Sales Conference in Kansas City February 10, Lang said that the power shortage "spook" which has been hovering over the electrical industry for the past five years never really materialized. Instead, he said, the utility companies are faced with an impending shortage of load which can be dealt with only through increased "sales power."

★ ★ ★

A NEW PRINT SHOW containing scientific and technical photographs of outstanding merit has just been made available by the Technical Division of the Photographic Society of America. Technical schools and societies and other interested groups may borrow this show for periods of a week or two at no charge other than the shipping expense.

Of particular interest are several photographs taken with the new 200-inch telescope at Mt. Palomar Observatory. Unusual views looking the other way—from the sky to the earth—are provided by pictures made from a rocket travelling into the stratosphere. A number of electron micrographs of interesting minute structures are presented also, some of which illustrate the very useful shadow-casting technique. Combined use of photography and modern knowledge of atomic disintegration is also demonstrated by the pictures, both in medical and physical science. High-speed photography, especially as related to underwater phenomena, and acoustical and other studies are also represented.

Requests for hangings should be sent in writing to Earl R. Clark, 184 Malden St., Rochester 13, N. Y., and should state any preference for dates.

★ ★ ★

MEMORY of the late Albert Kingsbury, of Greenwich, Conn., educator, inventor and manufacturer, will be honored in the naming of the University of New Hampshire's new technology building at Durham, N. H. It has been named Albert Kingsbury Hall.

While teaching at New Hampshire he invented what has come to be known as the Kingsbury thrust bearing. Later he founded the Kingsbury Machine Works, Inc. of Frankford, Pa., manufacturers of bearings for many types of industrial use.

Now You Can Order From Stock

THE NEW EDWARD PREMIUM TYPE Fig. 444-8 SERIES

at STANDARD VALVE PRICES!

Here is a new line of forged steel globe and angle valves incorporating many features you expect only in premium-priced valves—but the new Edward Fig. 444 series is priced the same as standard valves.

And most sizes and types are available for shipment from factory stocks or from many local distributors.

Here at last is an all-purpose valve line—in either 600 or 1500 lb sp, and in sizes ¼ to 2 in.—with all the features valve buyers want most. For instance . . .

- Simple repacking with both hands free . . .
- All drop forged steel for greatest strength at high pressures or temperatures . . .
- Tight, easily accessible bolted or union bonnet joints . . .
- Bronze yoke bushings to prevent stem seizing or galling . . .
- Low pressure loss body contours . . .
- Mated seats and disks checked for perfect fit on Edward Micron-O-Scope . . .
- EValpak heat-resistant die-molded packing . . .
- Screwed or socket welding ends . . .
- O. S. & Y. . . .

Standardize—at standard valve prices—on the premium-type Edward Fig. 444 series. A new bulletin is ready for you.

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

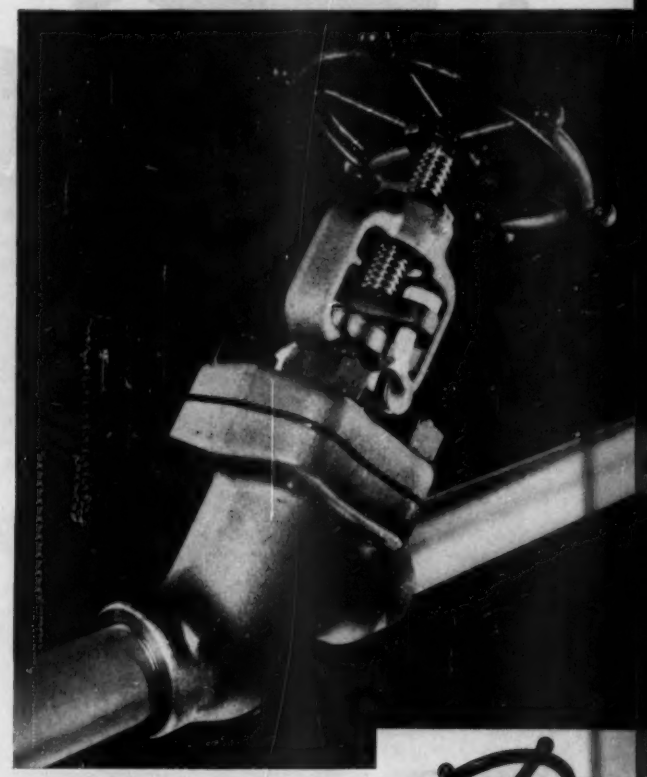
Edward Valves, Inc.
220 West 144th Street, East Chicago, Indiana

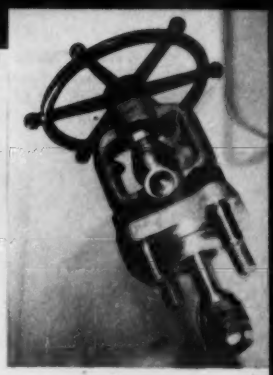
Please send me the new 501 Bulletin.

Name_____

Street_____ Zone____ State_____

City_____





MAINTENANCE MAN'S DREAM

Gland bolts swivel out of way but can't come off. Gland rests on yoke. Plenty of room between stem and yoke. Both hands free for repacking.

BONNET ASSEMBLY HAS EVERYTHING

Built-in pressure-tight backseat. Bronze yoke bushing. External threads EValized against corrosion. EValloy stainless steel stems, EValloy or Stellite seats and disks. Easy-grip non-skid handwheels.

TWO

Yarway Type "B" Seatless Tandem Blow-Off Valve. For pressures to 400 psi. Ask for Bulletin B-424.

YARWAY

REASONS

FOR USING

GOOD BLOW-OFF VALVES

1. To be sure of *tight* blow-down lines.

2. To withstand the severe punishment of regular or emergency blowing-down under pressure and periodic acid wash.

Yarway Blow-Off Valves are *good* blow-off valves—designed and built to safeguard beyond any doubt your sizeable boiler investment.

To give you drop-tight protection required for efficient boiler operation, Yarway offers Seatless Valves that have no seat to score, wear, clog and leak . . . or heavy-duty Yarway Stellite Hard-Seat Valves.

Either valve, or any tandem combination, also provides ruggedness and safety beyond any emergency requirements.

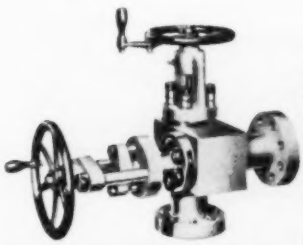
It is no coincidence that more than 15,000 boiler plants throughout the world use Yarway Blow-Off Valves . . . and among high pressure plants, 4 out of every 5 are Yarway-equipped.

For the full story on blow-off valves for *your* boilers, write today for the Yarway Bulletin. *Please mention pressure range.*

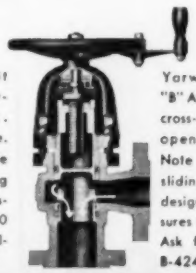
YARNALL-WARING COMPANY

114 Mermaid Avenue, Philadelphia 18, Pa.

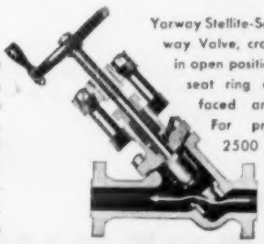
Branch Offices in Principal Cities



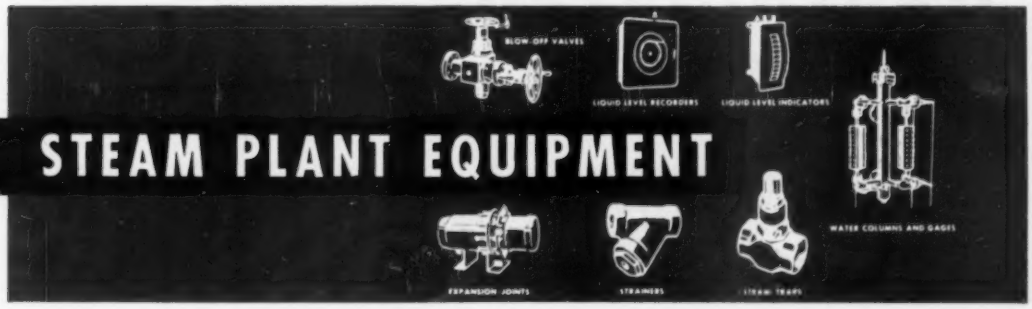
Yarway Unit Tandem Blow-Off Valve. Flanged type. Also available with welding ends. For pressures up to 2500 psi. Ask for Bulletin B-432.



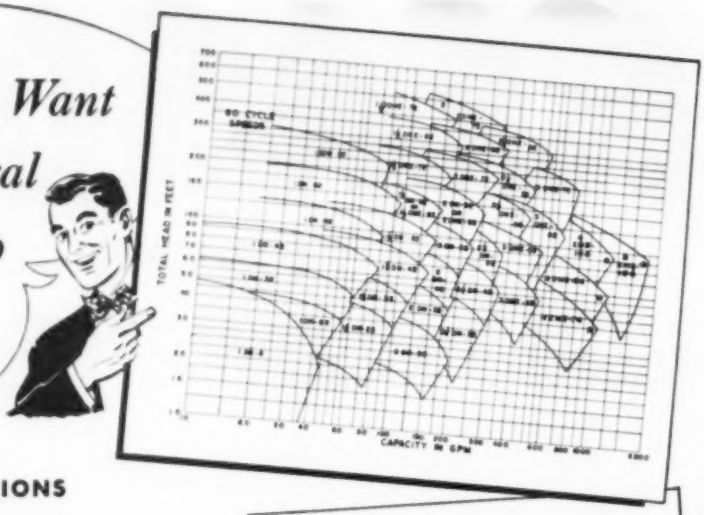
Yarway Type "B" Angle Valve, cross-sectioned in open position. Note balanced sliding plunger design. For pressures to 400 psi. Ask for Bulletin B-424.



Yarway Stellite-Seat Straightway Valve, cross-sectioned in open position. Disc and seat ring are stellite-faced and ground. For pressures to 2500 psi. Ask for Bulletin B-432.



Whatever You Want in a General Utility Pump ...Here It Is!



OVER 10,000 STANDARD COMBINATIONS WITH WORTHINGTON CN AND DN CENTRIFUGALS!

The modern answer to today's small pump problems – Worthington CN and DN Pumps offer a breadth of coverage and a choice of style that will suit your requirements to a T. Hydraulically, both types are identical. Their liquid ends, of the same highly efficient, up-to-the-minute design, are interchangeable, and can be equipped with either conventional packing or mechanical seal.

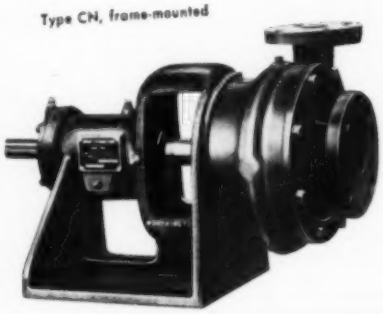
Type CN, frame-mounted, is a real "any-drive" pump — readily driven by an electric motor, V-belt, or any other mechanical power-source. Type DN is the famous Worthington Monobloc design — compact, streamlined, with built-in motor.

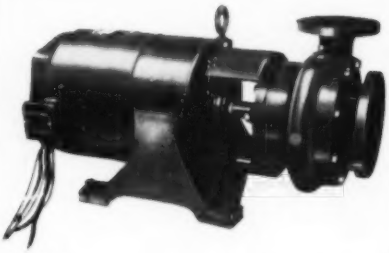
This Is Real Coverage

With the CN and DN you have 40 sizes of pump-castings to choose from, with capacities from 10 to 1750 gpm and heads from 20 to 500 ft., as shown on the above chart. There are 200 combinations of frame-mounted designs and, considering both type pumps, over 10,000 standard combinations! Despite this wide range — the CN and DN pumps are designed to have maximum interchangeability of component parts.

From this vast selection you're sure to find the combination that will meet your pumping needs. That means the end of compromising with pumps that are not just right for *you* — and the beginning of the money-saving performance that proves *there's more worth in Worthington*. For details, contact our nearest District Office, or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, New Jersey.*

Type CN, frame-mounted





Type DN, Monobloc

WORTHINGTON

CD-7

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB

HIGH DIFFERENTIALS
ARE NO PROBLEM
with HAGAN
Ring Balance Meters

With ordinary meters, high differential pressures present serious difficulties—but not with the Hagan Ring Balance Meter.

Hagan meters for differentials up to 420 inches of water require exactly the same size case as low-differential meters. There is no drop leg, no U tube—everything is inside the case.

With both high-differential and low-differential Hagan Ring Balance Meters, checking and calibration are done by the same simple method, using a set of check weights which are furnished with the meter. The water column method, which is especially cumbersome when high differentials are involved, is unnecessary, and it offers no routine advantages over the check weight method.

For full information on Hagan Ring Balance Meters, fill in the coupon below or write to Hagan Corporation, Hagan Building, Pittsburgh 30, Pennsylvania.

HAGAN CORPORATION

RING BALANCE FLOW AND PRESSURE INSTRUMENTS
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS

Hagan Corporation
Hagan Building
Pittsburgh 30, Pennsylvania

Please send me further information on Hagan Ring Balance Meters. I am particularly interested in_____

NAME_____

POSITION_____

COMPANY_____

STREET AND NUMBER_____

CITY_____ ZONE____ STATE_____

G2

SUNBURY

a tradition of leadership

On the evening of July 4th, 1883, Thomas A. Edison placed in operation the first three-wire central station electric lighting plant in the world at Sunbury, Pa. Power was supplied to the old City Hotel three blocks away which was then on the site now occupied by the Hotel Edison.

The world's largest power plant using pulverized anthracite has been completed recently on a site near Shamokin Dam along the Susquehanna River about two miles below Sunbury, Pa. This 150,000 kw installation, first of a number planned for the site, is part of the Pennsylvania Power & Light Company's network serving 28 counties which cover an area of 9,500 sq miles in central eastern Pennsylvania.

The two 75,000 kw turbine generators are served by four 130-ft high Foster Wheeler Steam Generators, the largest ever built for direct firing of pulverized anthracite.

An extension of 100,000 kw capacity, now under construction, will be completed in 1951 and equipped with Foster Wheeler Steam Generators.

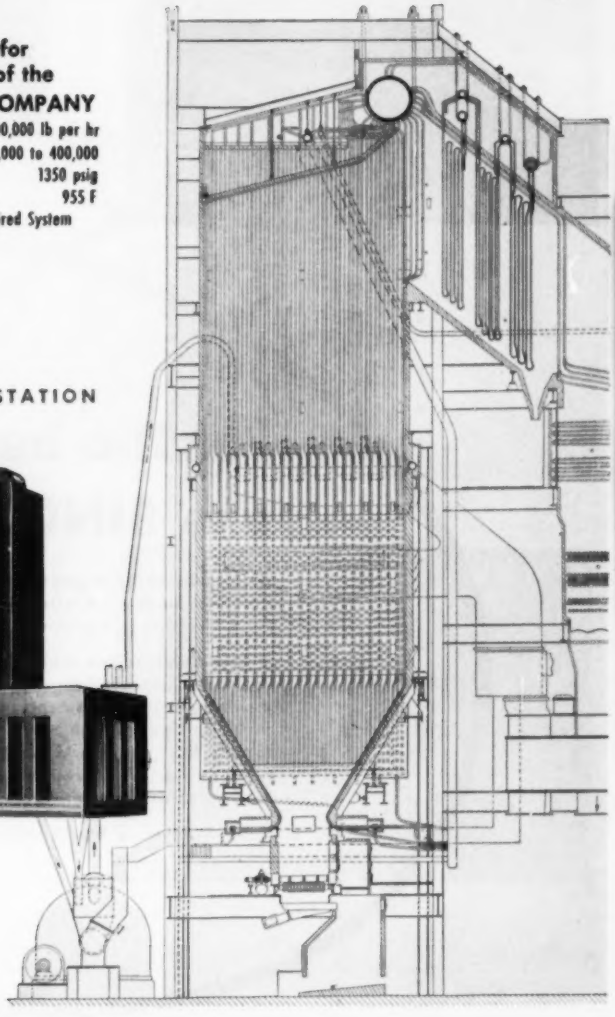
FOSTER WHEELER CORPORATION · 165 BROADWAY

Four FOSTER WHEELER Units for Sunbury Steam Electric Station of the PENNSYLVANIA POWER & LIGHT COMPANY

Capacity	400,000 lb per hr
Superheat Control Range	250,000 to 400,000
Pressure Superheater Outlet	1350 psig
Final steam Temperature	955 F

Anthracite Coal Pulverized in FW Ball Mills in Direct Fired System

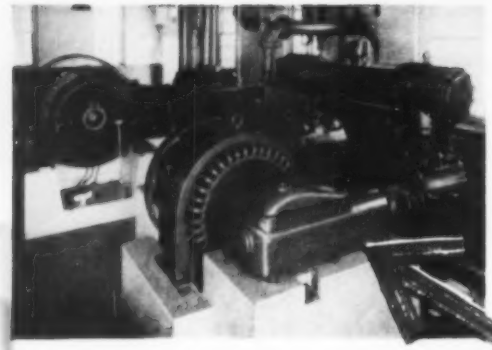
NEW SUNBURY STEAM ELECTRIC STATION

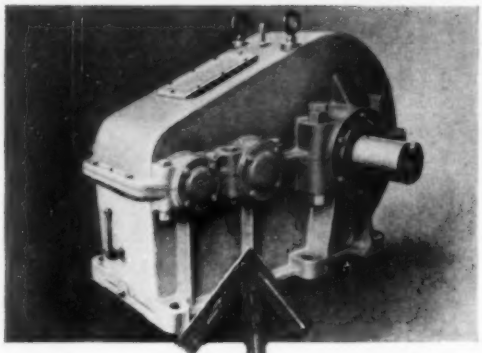


Each steam generator is equipped with two Foster Wheeler ball mill pulverizers which have a combined output of 27 tons of coal per hr.

FOSTER WHEELER

NEW YORK 6, N. Y.





For the best lubrication use SINCLAIR RUBILENE

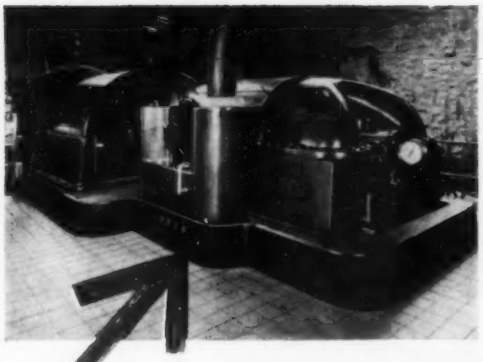
Over many years engineers in power plants throughout the country have accepted Sinclair's Rubilene as the finest available lubricant for power house equipment.

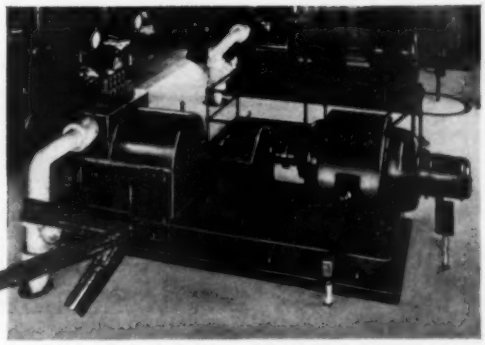
Sinclair Rubilene has always been a top-quality oil, as it has been constantly improved through the years, incorporating the latest technological developments in refining and processing. It resists oxidation under continuous high temperatures, and recirculation. It separates rapidly from water and is non-foaming. Through long periods of use it retains its original qualities, providing uniform, trouble-free lubrication and low maintenance costs.

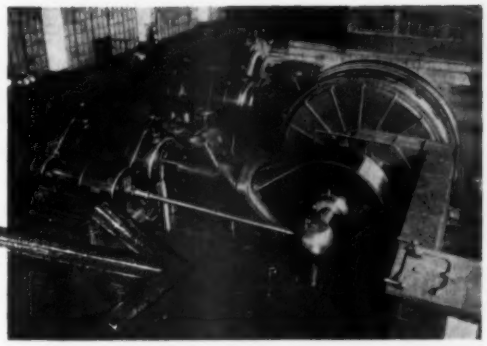
Yes... Rubilene's finer quality pays dividends in the power plant.

SINCLAIR

For lubrication counsel . . . see your nearest







REFINING COMPANY

Supplier of Sinclair Products or write to Sinclair Refining Company, 630 Fifth Ave., New York 20, N. Y.

IT'S CHEMICAL ACTION!

NO IT'S GALVANIC ACTION!

WHAT CAUSES CORROSION?

CHEMICAL ACTION? . . . low pH, dissolved oxygen, magnesium chloride, dissociation, caustic embrittlement?

GALVANIC ACTION? . . . electrolysis, non-uniformity of the surface, copper deposits?

Is it Chemical Action? Galvanic Action? Or both? There are many borderline cases and while *types* of corrosion can be determined—etching, pitting, gouging, grooving, cavitation, erosion, embrittlement—actual *causes* are frequently obscure.

The Drew System of Water Treatment eliminates guesswork! It starts with proper diagnosis. It includes recommendations for corrective treatment and other preventive measures such as modification of operating cycles and redesign of equipment, if required. It is specialized service applied to your individual boiler problem.

Corrosion can be prevented! If it exists in your boilers, steam lines, feed pumps, heaters, economizers, consult the Drew Engineer or write for further information.

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

DREW PRODUCTS

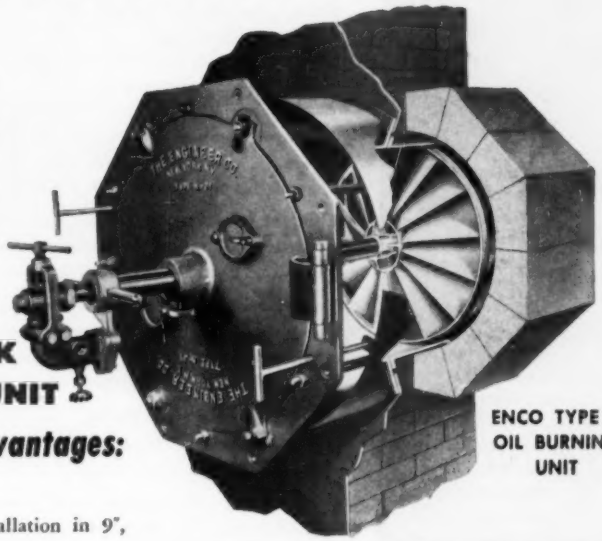
NATIONWIDE SERVICE IN BOILER WATER AND COOLING WATER CONDITIONING

NOW! uniform combustion efficiency from high peaks to low loads with the

ENCO TYPE K

OIL·GAS BURNER UNIT

HERE'S THE LATEST advance in burner units, designed to provide completely uniform combustion over the entire load range. The new ENCO Type K Oil-Gas Burner Unit is especially effective where steam demands swing sharply over short periods.



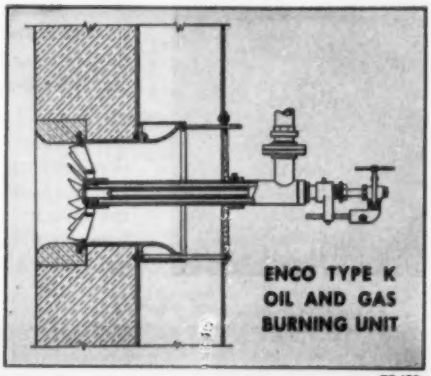
ENCO TYPE K OIL BURNING UNIT

THE ENCO TYPE K OIL·GAS BURNER UNIT

Offers These Additional Advantages:

1 Natural or forced draft operation.
2 Register draft tube designed for installation in 9", 13½", 18" and 22½" furnace walls.
3 No movable blades.
4 Air vanes provide fixed turbulence over entire load range. Adjustable for long or short flame.
5 Air volume control damper.
6 Hinged door for easy access to internal parts for inspection or removal.
7 Suitable for either steam or mechanical atomizing type oil atomizers.
8 Gas burner gun can be added for combination of gas and/or oil.
9 Comes in a wide range of sizes and capacities.

This new Type K Unit is the result of pioneering research, aimed to help you achieve more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.



ENCO TYPE K OIL AND GAS BURNING UNIT

BO-479

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, N. Y.

6 reasons why

...Industry after Industry has selected the VERTICAL-UNIT BOILER

AUTOMOBILE
BAKERIES
BREWERIES
CEMENT
CHEMICAL
COLD STORAGE
DAIRIES
DISTILLERIES
FOOD
GLASS
HOSIERY
HOSPITALS
INSTITUTIONS
LAUNDRIES
LEATHER
LINOLEUM
MACHINERY
METALS
OIL
PACKING
PAINT
PAPER
RAILROADS
RUBBER
SCHOOLS
STEEL
SUGAR
TEXTILE
TOBACCO
UTILITY

A glass plant in Ohio . . . a chemical plant in West Virginia . . . a floor covering plant in Delaware . . . plant after plant, representative of virtually every branch of industry, has chosen the C-E Vertical-Unit Boiler, Type VU-10 to meet its particular steam requirements. Here are six important reasons for the VU-10's industry wide acceptance:

Balanced Design – Not one or two features for special needs, but a *completely balanced design* that adapts itself to many conditions. A design in which each element is coordinated with every other for top performance.

Efficient Performance – The VU-10 has high efficiency over a wide range of output, produces steam of satisfactory quality at all ratings and responds to rapid load swings . . . all characteristics of advantage to many industrial plants.

Easy Operation and Maintenance – The VU-10 is simple to operate and maintain – especially advantageous for plants with limited operating and maintenance forces. All parts readily accessible for such cleaning and maintenance work as may be necessary.

Choice of Fuels and Firing – In addition to its wide adaptability, the VU-10 permits you to choose the one *best* method of firing for the fuel and load conditions of *your* plant.

Lower Cost – The standardized balanced design of the Vertical-Unit Boiler effects economies in engineering, fabrication and erection which are passed on to you in lower first cost.

Unified Responsibility – The Vertical-Unit Boiler is a complete unit . . . boiler, furnace setting, fuel-burning equipment, controls, forced draft . . . bringing you the added benefit of one contract, one guarantee and one responsibility.

* * *

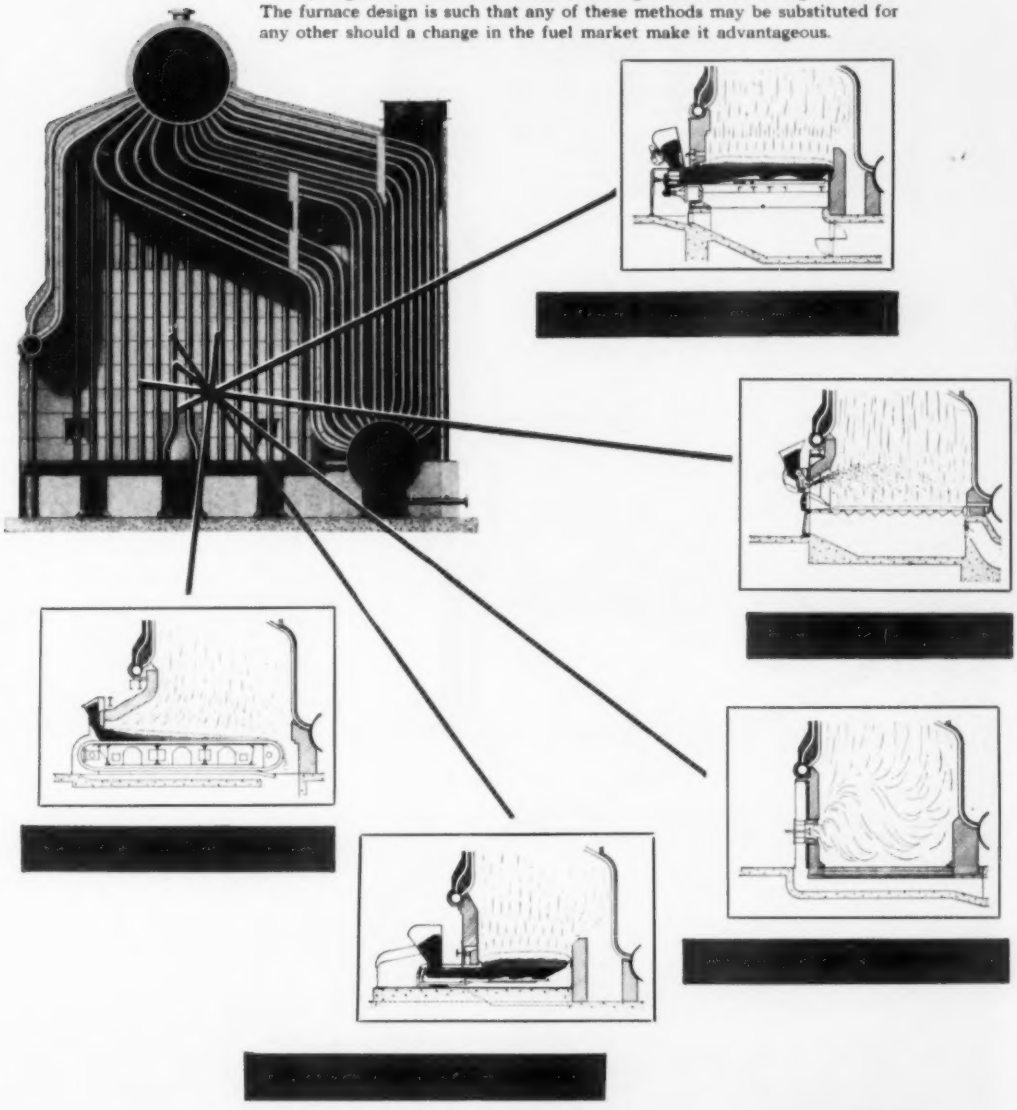
The design, construction and operating features of the VU-10 meet all the requirements of a modern industrial plant. Small wonder so many diverse industries select this unit for their steam needs. If your requirements fall within the capacity range, 10,000 to 60,000 lb of steam per hour, it will pay you to investigate the VU-10. Our engineers will welcome the opportunity to discuss the matter with you or your consultants at your convenience. B-381

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

For every fuel market and every type of load there is *one best* method of firing. The selection of that *one best* method for the fuel and load conditions of a particular plant calls for judgment based on broad experience and free from any incentive to favor one type of equipment over another.

The Type VU-10 Boiler is designed for five methods of firing – spreader stoker, single-retort underfeed stoker, chain grate stoker, oil or gas burners. The furnace design is such that any of these methods may be substituted for any other should a change in the fuel market make it advantageous.



— SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

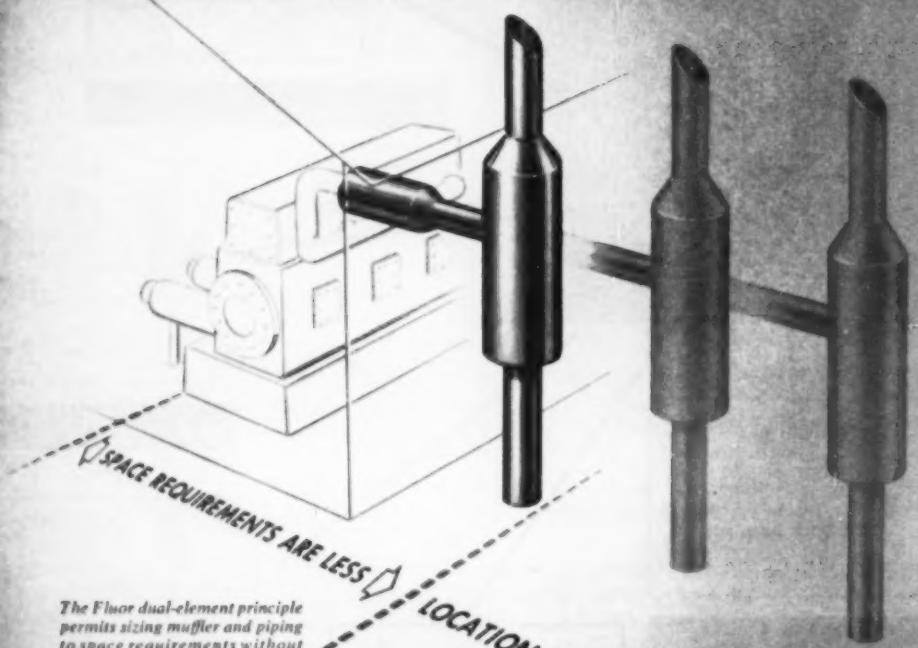
See for yourself...

the installation advantages of a FLUOR SERIES "D" MUFFLER SYSTEM

The reason lies in the unique dual-element design of this muffler *system*. Work is started on pulsative exhaust gases at the engine—noise and pulsation reflections are virtually eliminated at their source. The Fluor Series "D" Muffler is a *system* that incorporates *two* muffling elements—a primary element located in the immediate proximity of the engine and a secondary element located *at any desired spot* outside the engine room.

The Fluor Series "D" Muffler System is the answer to your muffling problems. In addition to installation flexibility it provides the highest muffling efficiency obtainable—*at a cost competitive with conventional mufflers.*

NO LONGER is ultimate muffling efficiency dependent upon trial-and-error locating of exhaust piping. With the Fluor Series "D," exhaust piping can be of *smaller* diameter, location of outside exhaust chamber *flexible* without affecting pressure drop or noise attenuation and pulsation reduction efficiency.



The Fluor dual-element principle permits sizing muffler and piping to space requirements without setting up hazards common to single-element mufflers.

All elements, including interconnecting piping, are engineered to a minimum in diameter.

Because muffling is spread throughout a Fluor Series "D" System, the outside muffling chamber can be set at any desired distance from the engine room wall.

AVAILABLE FROM STOCK—A Fluor Series "D" Muffler System to fit virtually any 2- or 4-cycle, 200 to 2400 HP diesel engine is available from stock. You need only submit engine room design and dimensions, make, model and RPM of engine and whether muffling system is to be air-cooled or non-air-cooled. Inquiries will be answered promptly.

THE FLUOR CORPORATION, LTD.

FLUOR

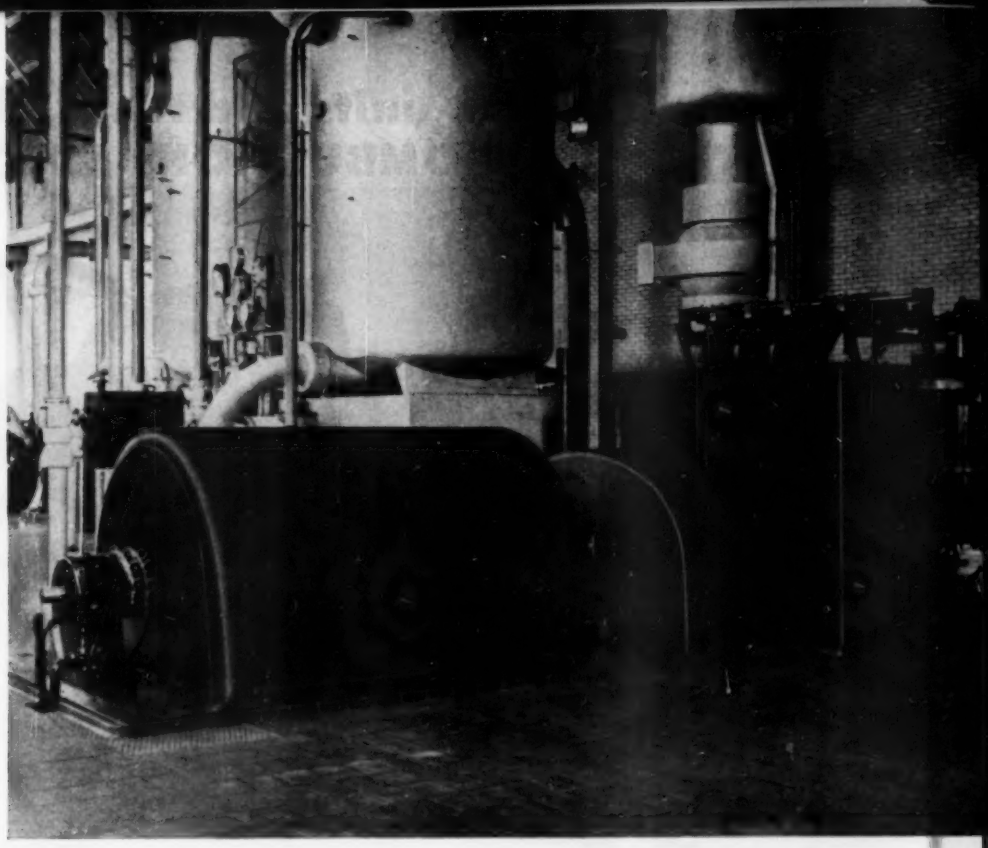
BE SURE WITH FLUOR

MANUFACTURERS of Mufflers, Pulsation Dampeners, Gas Cleaners, Cooling Towers and Fin-Fan Units.

DESIGNERS AND CONSTRUCTORS of Refinery, Natural Gas and Chemical Processing Plants.

2500 E. ATLANTIC BLVD., LOS ANGELES 22, CALIF.
Offices in principal cities in the United States

Represented in the Sterling Area by:
Head Wrightson Processes Ltd., Trinidad House, Baltic Street, London, E.C.1., England



Used 18 years, oil goes right back on the job

● In 18 years of operation, the original fill of NONPAREIL Turbine Oil was never removed from this 2500-KW turbine at the University of Michigan power house. Neutralization numbers always stayed below 0.07 mg. KOH/gm. Tests of oil samples showed no deterioration of the lubricant.

Recently, the turbine was shut down for inspection and general overhaul. Operators drained NONPAREIL from the unit and took a close look at the oil system. *They found no oil deposits, no evidence of rust, and not a sign of corrosion.* The oil itself was in excellent condition and after centrifuging it was returned to the turbine for continued use.

You, too, can obtain such lubrication advantages. By switching to NONPAREIL Turbine Oil, you can eliminate oil acidity troubles and oil system maintenance once and for all. These benefits are not only indicated by the experience of others but are backed by the written guarantee you receive that NONPAREIL will last as long as the turbine and that its acidity will stay below 0.15 mg. KOH/gm.

A Standard Oil lubrication specialist will be glad to supply you with actual case histories of utility operations on which Nonpareil Turbine Oil has reduced lubrication costs as much as 68%. To arrange for his visit, write: Standard Oil Company (Indiana), 910 S. Michigan Ave., Chicago 80, Ill.

NONPAREIL
Turbine Oil

"WILL OUTLAST YOUR TURBINE"

STANDARD OIL COMPANY (INDIANA) STANDARD

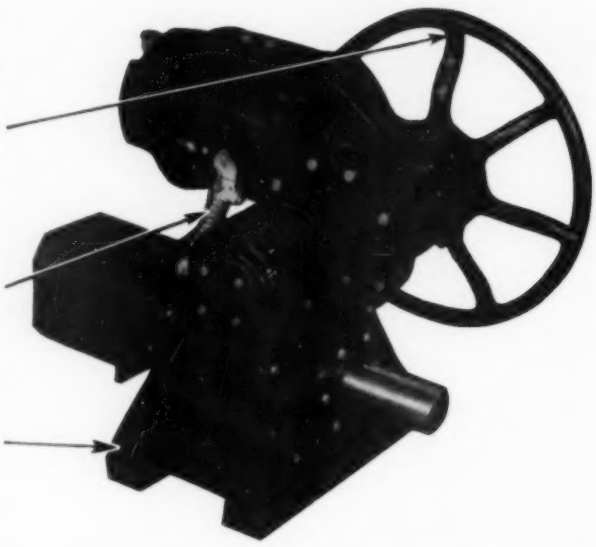
How electric drive units add to reliability of METERMAX COMBUSTION CONTROL

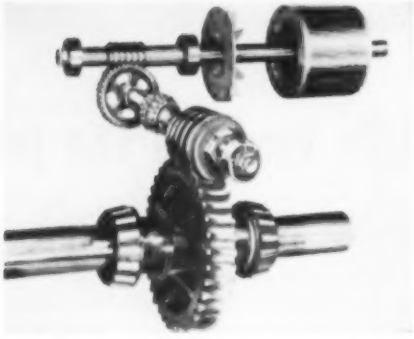
When you're thinking about combustion control, it pays to consider the parts of the system which do the "muscle work" of moving dampers, valves and vanes. In Metermax control, this is done by electric drive units, whose operating features contribute greatly to Metermax performance.

Easy Manual Setting. Ordinarily nothing interferes with the operation of these units except failure of the plant power supply. In emergencies, each controlled element can be moved manually by means of its handwheel. There's no need to disconnect linkages. Gear reduction enables operator to move even heavy dampers easily, quickly.

No Clogging. Because they're operated by electrical power, drive units are immune to clogging and freezing of power lines. Units can be mounted outdoors without any special precautions. Operation is just as reliable as the plant's power supply.

Simple Installation. Complete linkage is provided with each unit. Mounting feet are integral with the drive mechanism—easily bolted to a steel or concrete base.





Self Locking. Output shaft is driven through a double worm and gear reducer which can't be backdriven. When power shuts off, dampers stay in their existing position. No remote locking or reset devices are needed. The drive is always ready to resume control action without any attention by the operator.

Simple Remote Control. With a single switch, operator transfers the whole boiler control from automatic to manual, or vice versa . . . making start-up, shut-down or emergency operation easier.

Accurate Position Indication. Remote indicators on the Metermax panel show true position of controlled elements. Friction load or sticking of dampers cannot cause false position measurement.

For complete details about Metermax Combustion Control, write Leeds & Northrup Company, 4973 Stenton Avenue, Philadelphia 44, Penna.

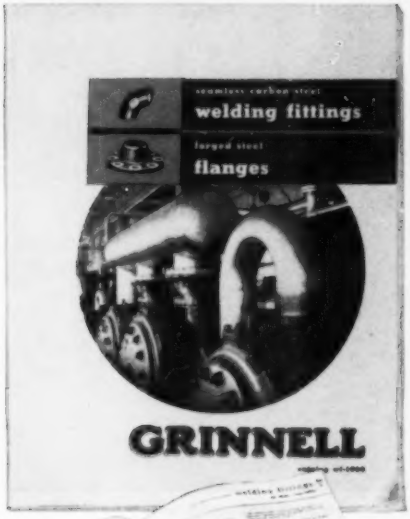
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Jrl. Ad NU9-01-463(2)

Yours for the asking
NEW CATALOG
with complete information

Grinnell welding fittings and forged steel flanges



Write today for your copy of the entirely new Grinnell Welding Fittings Catalog.

Table of Contents

SEAMLESS CARBON STEEL BUTT WELDING FITTINGS

- 90° elbows . . . long radius, short radius, light gauge, special wall thicknesses
- 45° elbows . . . long radius, light gauge, special wall thicknesses
- 180° returns . . . long radius, extra long radius, short radius, light gauge, special wall thicknesses
- tees . . . straight, reducing
- crosses
- reducers
- laterals
- lap joint stub ends
- caps
- saddles
- backing rings
- dimensional tolerances

FORGED STEEL FLANGES

- welding neck . . . 150 to 2500 lbs.
- slip-on . . . 150 to 2500 lbs.
- lap-joint . . . 150 to 2500 lbs.
- threaded . . . 150 to 2500 lbs.
- blind . . . 150 to 2500 lbs.
- socket type . . . 150, 300, 600 lbs.
- reducing . . . threaded and slip-on: 150 to 2500 lbs.
- orifice . . . slip-on; welding neck; welding neck, ring joint; threaded: 300 to 1500 lbs.
- flange extras
- dimensional tolerances
- minimum finished bores
- flange facings
- facing dimensions of ring joint flanges
- thread standards and threading practice
- service pressure ratings
- physical and chemical requirements

GRINNELL

Grinnell Company, Inc., Providence 1, R.I. Warehouses: Atlanta • Buffalo • Charlotte • Chicago • Cleveland • Cranston • Fresno • Kansas City • Houston • Long Beach Los Angeles • Milwaukee • Minneapolis • New York • Oakland • Philadelphia • Pocatello • Sacramento • St. Louis • St. Paul • San Francisco • Seattle • Spokane

YOU'LL SAVE MONEY WITH A SPREADER

YOU'LL SAVE EVEN MORE WITH A . . .

View of a recent Perfect Spread Stoker installation consisting of four traveling grate spread stokers, 10' wide x 14'3" long. They are installed under Wickes four drum bent tube boilers and have a continuous capacity of 60,000 lbs. per hour. Consulting Engineers were Albert Kahn, Associates.

Only Perfect Spread Stoker assures even coal distribution . . . won't clog on wet coal . . . has a cinder return system that works . . . adjustable overfire air

THERE'S NO GUESSWORK about it. You'll save real money – important sums regularly – with a spreader stoker. It enables you to burn a wide range of coals, including the cheaper, high ash coals, with top efficiency. No more paying premiums for coal when you have a spreader stoker. You utilize the coals that are attractively priced in your locality.

IN SPREADER STOKERS – IT'S PERFECT SPREAD – FOR MOST STEAM AT LEAST COST

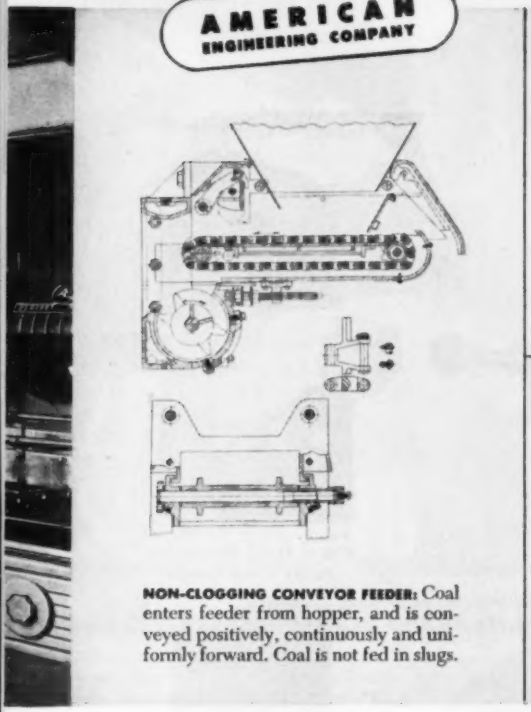
Exclusive features, unique in design, make the Perfect Spread Stoker the most efficient spreader that has ever been built. First and foremost, its feeder assures positive, continuous and accurate coal feed . . . it won't clog even when coal is wet. Next, the spiral overthrow rotor is unmatched for *even* coal distribution. And the engineered cinder reinjection and adjustable overfire air system are final assurance of superior fuel combustion.

Perfect Spread Stokers are made in both continuous discharge, dumping and stationary grate types. Coal feed is adjustable from 50 lbs. to 7,500 lbs. of coal an hour per feeder. Capacities range from 8,000 to 500,000 lbs. of steam per hour. Mail coupon on next page for full information . . . and be sure to call in your Consulting Engineer for recommendations regarding your requirements.

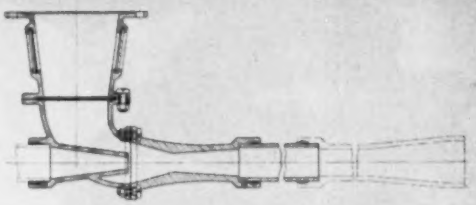
STOKER *BUT* . . . .

PERFECT SPREAD STOKER

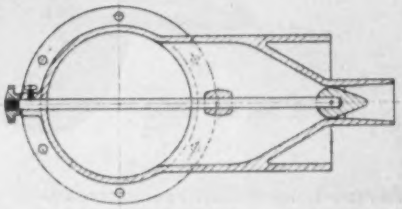
AMERICAN ENGINEERING COMPANY



NON-CLOGGING CONVEYOR FEEDER: Coal enters feeder from hopper, and is conveyed positively, continuously and uniformly forward. Coal is not fed in slugs.



ENGINEERED CINDER REINJECTION SYSTEM: An extremely efficient system; all fittings of alloy iron. Air driven through the venturi section sucks cinders into the air stream for return to the furnace. A *separate* line is provided for each cinder drain point.

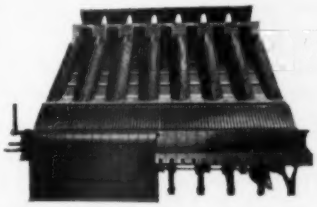


ADJUSTABLE OVERFIRE AIR SYSTEM: Most of the overfire air enters furnace through nozzles in side or rear walls. Each nozzle is a separate venturi-type unit and *individually* adjustable.

WHERE UNDERFEED STOKERS ARE INDICATED YOU CAN'T BEAT THE TAYLOR STOKER

Taylor Underfeed Stokers of adequate grate area deliver over 90% of the ash to the ashpit . . . and most of the remainder is collected in boiler passes without expensive dust recovery equipment.

Shown at right is a 7-Retort, 25 Tuyere Taylor Stoker. It provides low-cost steam for plants of moderate size. The principles of combustion are identical with those of the high capacity Taylor Stokers that are the standard for central stations and large industrial plants.



AE

AMERICAN ENGINEERING COMPANY

PHILADELPHIA 25, PENNA.

Other AE Products are Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Car Shakers, Car Pullers.

American Engineering Company
2408 Aramingo Ave., Philadelphia 25, Pa.

Gentlemen: We are interested in "most steam at least cost." Send me full information about ____ Perfect Spread Stokers; ____ Taylor Stokers.

Name _____ Title _____

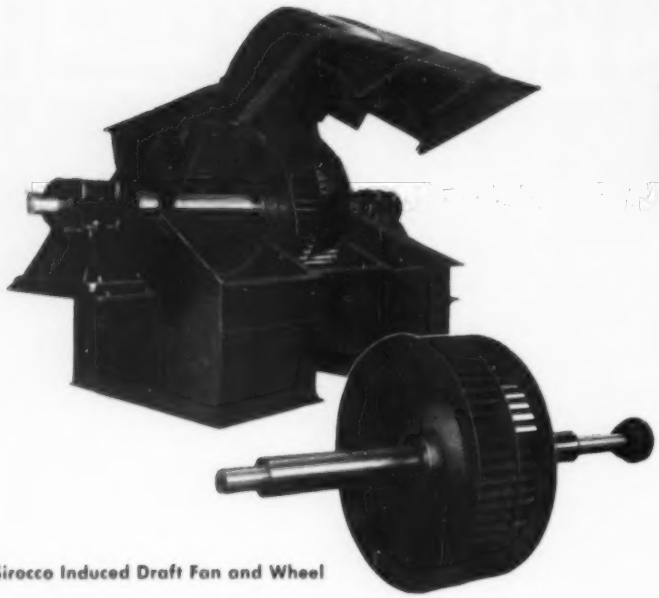
Company _____

Address _____

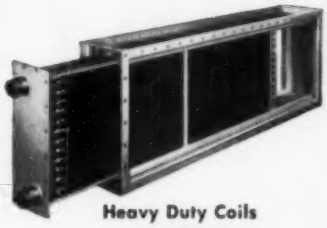
City _____ Zone ____ State _____

SIROCCO INDUCED DRAFT FANS

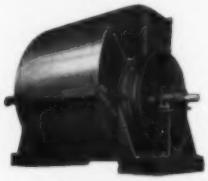
Standard of the World



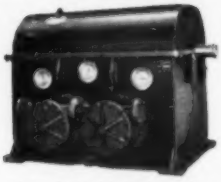
Sirocco Induced Draft Fan and Wheel



Heavy Duty Coils

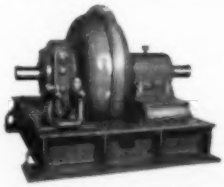


American HS Forced Draft Fans



Gýrol Fluid Drives for Boiler Feed Pumps

Type ST Fly Ash Precipitators



Type VS Gýrol Fluid Drives for Mechanical Draft Fans

The Sirocco Induced Draft Fan (shown above) with die-formed forward curved wheel blades is designed and proportioned specially for induced draft work. **Now used on 1,000,000# /hr. steam boilers.**

The high static efficiency, low RPM, low tip speed, low inlet velocity, plus other important operating characteristics, make this fan particularly well adapted to severe power plant requirements.

For complete, concise, factual data on the Sirocco Induced Draft Fan, write for Bulletin 4424.

For data on other American Blower Mechanical Draft Equipment, Fly Ash Precipitators, Heavy Duty Coils and Gýrol Fluid Drives for fan control and boiler feed pumps—consult your nearest American Blower Branch Office.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

YOUR BEST BUY AMERICAN BLOWER POWER PLANT EQUIPMENT

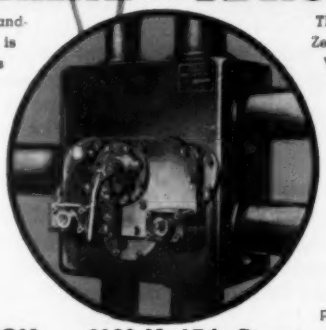
Serving home and industry

AMERICAN-STANDARD · AMERICAN BLOWER · CHURCH SEATS · DETROIT LUBRICATOR · KEWANEE BOILERS · ROSS HEATER · TONAWANDA IRON

with the COCHRANE HYDROMATIC VALVE

The new Cochrane Hydromatic Valve, standard equipment on Cochrane Zeolite Softeners, is readily adaptable to automatic control. This is a fact of prime importance to any user of zeolite softeners for, with the Hydromatic Valve, no change in the physical plant is necessary — merely the simple addition of a control box and a small drive motor.

Automatic operation of Zeolite Softeners makes possible economies in the amount and cost of the zeolite materials that often offset the cost of the control accessories, aside from the convenience of the automatic operation.



The points in favor of Cochrane Automatic Zeolite Softening System with the Hydromatic Valve are these:

1. Simplest and most positive single control valve ever built—six valves in one.
2. Automatic Control with the Hydromatic Valve means merely the addition of control box and a small 1/30 H.P. drive motor—no changes in the physical plant.
3. Cost of labor attendant on manual operation is eliminated.
4. No objection to shorter regeneration period permitting savings on amount and capacity of zeolite materials.

COCHRANE CORPORATION • 3123 N. 17th Street • PHILADELPHIA 32, PA.

In Canada: Canadian General Electric Company, Ltd., Toronto

COCHRANE

SOFTENERS • FILTERS • DEAERATORS • SPECIALTIES

COCHRANE CORPORATION
3123 N. 17th St., Philadelphia 32, Pa.
In Canada: Canadian General Electric Co., Ltd., Toronto

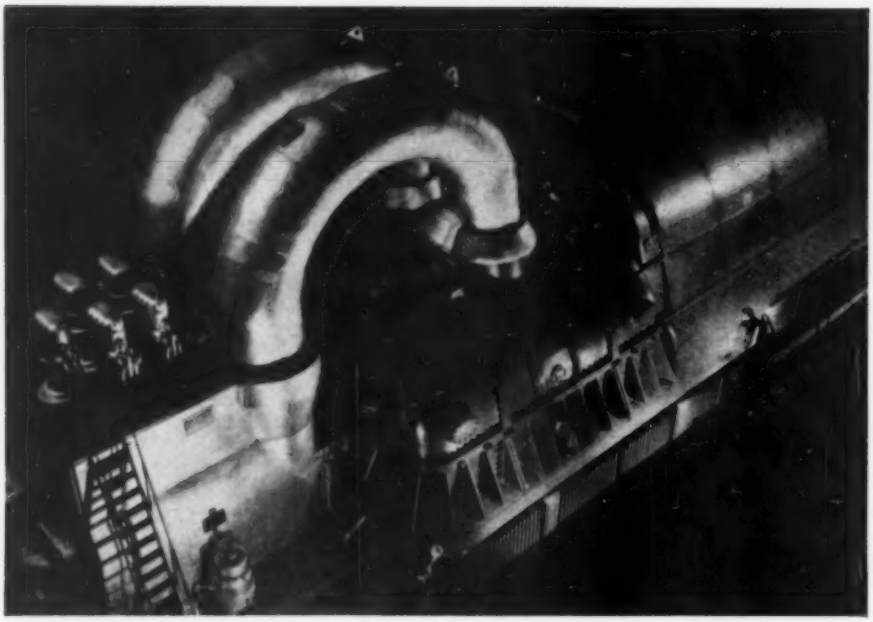
Please send me a copy of your latest bulletins on Zeolite Softeners and the Hydromatic Valve.

Name.....

Firm.....

Address.....

City.....*State*.....



Why Philadelphia Electric Company

PROTECTS ITS TURBINES *by CENTRIFUGAL FORCE*

This great power company uses De Laval centrifuges to purify the lubricating oil used in three different classes of turbines:

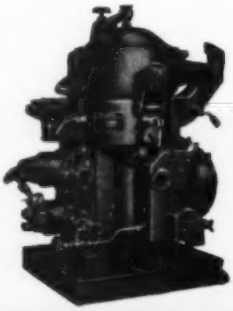
(1) Large turbines, with moderate steam pressure and temperature, and large volume of oil in the system

(2) Low pressure, low temperature turbine of moderate size with relatively small volume of oil in the system

(3) Topping turbine: high pressure, high temperature; larger quantity of lubricating oil

The De Laval machines remove the particles of dirt which may be picked up from the system ***and*** they remove any moisture that may be in the oil. Where inhibited oils are used, the centrifuge purifies the oil without removing the additives — an important advantage of centrifugal force.

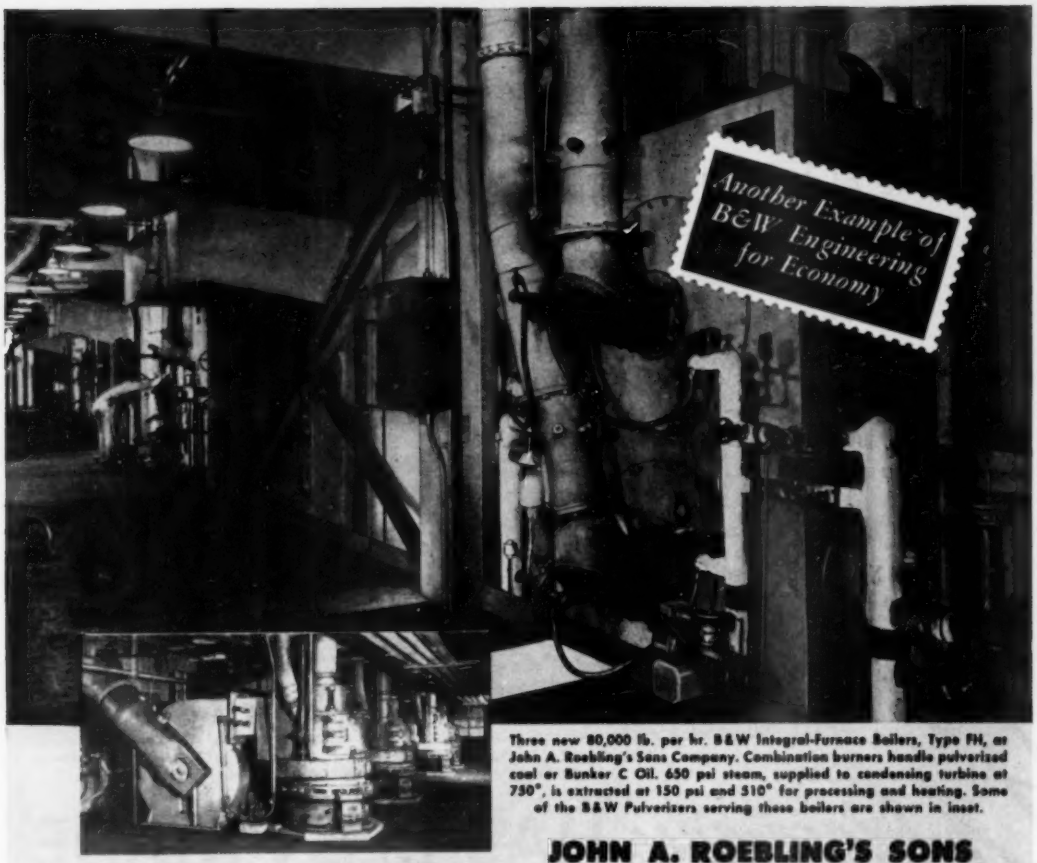
In a word, De Laval centrifugal machines offer complete protection to all classes of turbines!



THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL

LUBRICATING OIL PURIFIERS



Three new 80,000 lb. per hr. B&W Integral-Furnace Boilers, Type FH, at John A. Roebling's Sons Company. Combination burners handle pulverized coal or Bunker C Oil. 650 psi steam, supplied to condensing turbine at 750°, is extracted at 150 psi and 510° for processing and heating. Some of the B&W Pulverizers serving these boilers are shown in inset.

JOHN A. ROEBLING'S SONS

REPORT $250,000 ANNUAL SAVINGS

WITH NEW POWER PLANT

Saving a quarter of a million dollars a year with a complete new power plant makes mighty good sense to profit-minded management. And that's just what John A. Roebling's Sons Co., Roebling, N. J., are doing with their new steam and electric generating plant — completely equipped with B&W Integral-Furnace Boilers, Type FH, and with B&W ball-bearing-type Pulverizers.

Generation of by-product electrical energy will result in savings of over $100,000 annually — increased boiler efficiency, reduced maintenance and operating labor costs will add another $150,000. These economies — which include a 9,000 ton annual reduction in coal consumption — are expected to pay for the plant in from 8 to 10 years. Constructors were the Rust Engineering Company.

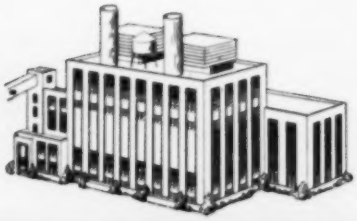
Like Roebling, you will find new paths to profits opened up when B&W Engineers are in on the start of any modernization or expansion program or the construction of an entirely new plant. Their advice has proved eminently sound for more than 80 years. Write today for Bulletin G-38. It gives you complete details on B&W Integral-Furnace Boilers, Type FH. The Babcock & Wilcox Co., 85 Liberty Street, New York 6, N. Y.

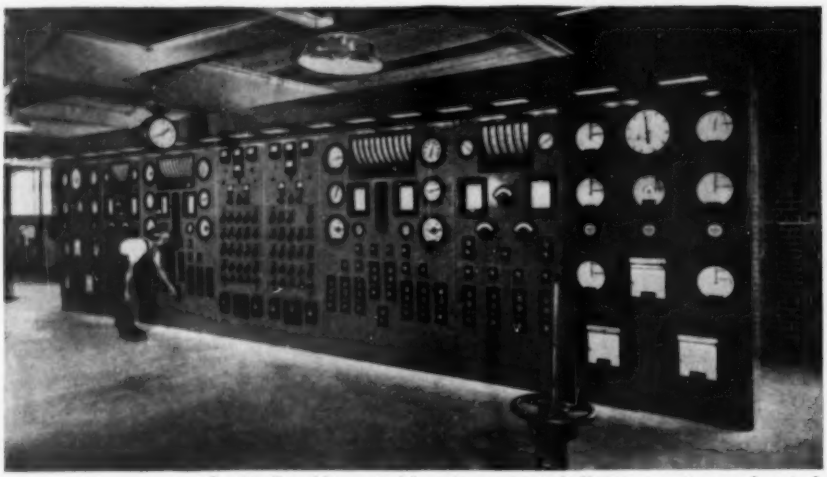
BABCOCK & WILCOX

Helping Industry Cut Steam Costs Since 1867

G-449

● at the New GADSDEN Steam Plant
of the Alabama Power Company





On this Republic control board are mounted all gauges, meters and controls for operating each of the two boilers and their auxiliaries.

Efficiency HAS BEEN MADE *Automatic*

It is the policy of Alabama Power Company to generate, transmit and distribute electricity to its customers at the lowest cost consistent with good service.

When designing the new 120,000 kw. Gadsden Steam Plant, the Alabama Power Company, in keeping with this policy, incorporated proven engineering developments which contribute to economical power generation. High among these was REPUBLIC automatic boiler control.

Two steam generators, each with a capacity of 600,000 pounds of steam per hour, and operated at 875 psig. and 885°F, supply steam to the two turbines. Fuels used are natural gas or pulverized coal, either singly, or in combinations.

The REPUBLIC control board is made up of one electrical panel, one recorder panel, and two combustion control panels per boiler.

The REPUBLIC combustion control system receives its initial impulse from the main steam line through the master controller which establishes a pneumatic loading pressure proportional to the boiler load. The loading pressure is transmitted to the variable speed coal feeders, and to the gas flow valve when burning gas in combination with coal. This pressure is also transmitted to the air flow regulator. A corrector regulator provides means for maintaining the proper steam flow air flow relationship. Provision has been made for manually adjusting this ratio from the boiler panel.

The boiler feedwater pumps are equipped with REPUBLIC automatic minimum flow hand reset valves. These valves open when the flow through the pumps is 150 gpm or less and by-pass this amount of water to the deaerating heater.

For complete information on REPUBLIC automatic boiler control write for Data Book No. S-21.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.

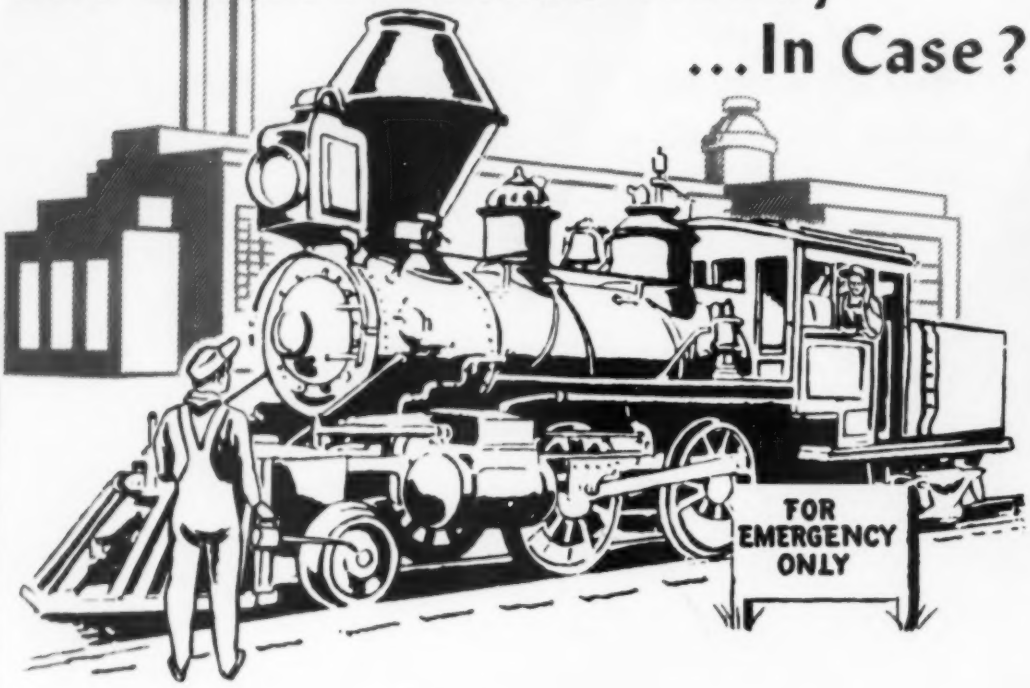
TUBE-TURN

Your nearby TUBE TURNS distributor can serve you right from stock. Call him for prompt delivery.

TUBE TURNS, INC., LOUISVILLE 1, KENTUCKY DISTRIBUTORS IN ALL PRINCIPAL CITIES

DISTRICT OFFICES: NEW YORK • PHILADELPHIA • PITTSBURGH • CHICAGO • HOUSTON • TULSA • SAN FRANCISCO • LOS ANGELES

Got a Locomotive Handy ...In Case?



EVERY so often a steam locomotive makes news by going to the rescue of a plant where the steam system gave out at a critical time.

This is one answer to continued steam production pending repairs . . . and undoubtedly an expensive one. Simplest—and most economical—is to use the Nalco System and eliminate the chances of boiler down time due to faulty water treatment.

Nalco chemicals and services aim at *water treatment results* from raw water intake to condensate hot well . . . And the thousands of plants now using the Nalco System testify to the accuracy of this aim during the past twenty-six years. Whether your plant is large or small; your water problems scale, corrosion, carry-over—or just plain high cost—unless you have a locomotive handy for emergencies, better check with Nalco today. No obligation . . . and an excellent chance for permanent water treatment security.

P. S. More steam locomotives use Nalco-treated water than any other kind . . . Perhaps the reason why locomotives *can* be of help in plant emergencies!

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

Canadian inquiries should be addressed to
Alchem Limited, Burlington, Ontario, Canada

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

ELECTRICAL

101 **Voltage Regulator—Manufacturer's** ¼ per cent step JFR pole-type regulator designed to correct rural low voltage conditions and improve service is described in 12-pp Bulletin 91B6434. Important features of the regulator are shown and reasons why it is simple to mount, operate and maintain are given. There is also a description of how the regulator provides full ±10 per cent regulation; how its quick-break mechanism is intended to lengthen contact life and cut maintenance, and how entire control is contained in one circuit, with voltage supply taken from a potential winding in the regulator. Allis-Chalmers Mfg. Co.

102 **Battery Manual—Publication GB-7-48A** is the revised second edition of company's 40-pp pocket-size manual of technical instruction and engineering data on the care of motive-power storage batteries. This edition contains a new 4-pp section on the theory of the lead-acid battery. Includes line drawings indicating what goes on when battery charges and discharges and basic information on specific gravity changes, charging and discharging cycles, positive and negative plate composition, and other battery operation principles. Other sections in book cover care and operation; maintenance and repairs; parts, and technical data. Gould Storage Battery Corp.

103 **Power Rectifiers—Eight-pp Bulletin 200** describes and illustrates in detail company's line of single phase tube type power rectifiers in d-c output capacities of 115 to 3000 w, for industrial applications. Commonly-asked questions on these rectifiers and their use are clearly answered under such headings as applications, construction, efficient, regulation, circuit employed, and by means of performance curves. Acurate Engineering Co.

104 **Conduit Cable Seal—Data Sheet** R1-2 introduces a recently developed cable entrance seal which can be utilized to advantage in many ways. Sketches illustrate its use in telescoping conduit connection, conduit through run and other applications. G & W Electric Specialty Co.

105 **Distribution Transformers—Bulletin** TU-100 is a collection of more than 100-pp of descriptive and engineering data covering standard transformers, surge protected transformers, rural line transformers and other types, including both liquid-filled and dry-type unit substation transformers, their standard equipment and accessories. Also discusses transformer performance and construction details and is profusely illustrated with photos and sketches. Includes consolidated price list. Wagner Electric Corp.

WATER TREATMENT

106 **Modern pH and Chlorine Control** —The new ninth edition of this 100-pp illustrated 6 by 9 in. paper-bound booklet has been revised to conform with the latest developments and most modern practice in water treatment. But it is much more than a catalog, although it does give full technical details of all the color comparators and equipment for water testing and control of boiler and industrial process water manufactured by this company. Its most important feature, however, is inclusion of much good technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Descriptions of color comparators are detailed and illustrated, with the prices listed; and include a new testing set for total hardness of water (technical details given in article in January, 1950, issue of POWER GENERATION.) W. A. Taylor & Co.

107 **Water Treatment and Equipment—Bulletin 5000**, 24-pp, covers principles and fundamentals of providing trouble-free water in boiler plant operation, for prevention of scale, pitting and general corrosion, for producing pure, dry steam, and avoiding caustic embrittlement. Gives description and coverage of company's products, adjustments of pretreatment and internal treatment, treatment application, blowdown and feed control. Describes testing apparatus and by diagram shows blowdown adjustment on six types of boilers. Features a large diagram covering tests to make and where to make them in a water and steam cycle power plant layout. Includes coverage of various types of feeders, pumps, tanks and motors. Dearborn Chemical Co.

108 **Chemical Feeder Data—Special** features of company's automatic chemical feeders, their operating principles and standard specifications are presented in Part 2, Section 8 of Catalog 54. This 16-pp book also describes and illustrates both a vertical and horizontal model. Hinck, Sivalls & Bryson, Inc.

109 **Chlorine Dispensers—Chlorine dispensing** equipment for use in direct-proportioning systems, high capacity systems, and gas injection systems is covered in Catalog 61, 12-pp. Explains and illustrates operation of dispensers, elaborating on design features. Fischer & Porter Co.

STEAM GENERATORS AND ACCESSORIES

110 **Packaged Steam Generators**—Illustrated with photos and dimensional drawings, 4-pp Bulletin PG-49-12 describes package steam generators for power or process steam at high or low pressures, for oil, gas or coal firing. Firing arrangements are discussed and illustrated in detail. Foster-Wheeler Corp.

111 **Tube Cleaners—Bulletin T-28**, 28-pp, describes and illustrates tube cleaners for all purposes. This handy guide covers applications of tube cleaners for removing scale and other types of encrustation from tubes or pipes in boiler room equipment, oil refineries, process plants and other locations. Various types of motors, cutter heads, drills, brushes, operating hose and couplings are fully described and the bulletin offers many help-

---

Use this CARD for information on ADS and NEW PRODUCTS also

FIRST CLASS
PERMIT No. 353
Sec. 34.9, P. L. & R.
CHICAGO, ILL.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

4¢ POSTAGE WILL BE PAID BY—

POWER GENERATION

53 West Jackson Boulevard

CHICAGO 4, ILLINOIS

APRIL, 1950
Card Void in 6 months

POWER GENERATION

Please have the manufacturers send me without obligation information or bulletins indicated by the following numbers.

_____

_____

_____

_____

_____

Your Name _____

Your Title _____

Your Company Name _____

Company Address _____

City _____ State _____

(If you prefer delivery at your home also fill below)

Home Address _____

City _____ State _____

Also, use this card for more information on advertised products.

[illegible] on the care and operation of tube cleaners. Lagomarsino Div., Elliott Co.

112 **Boiler Water Feeders**—Bulletin C-41A is a condensed catalog, 4-pp, with current price list covering company's line of feeders for steam and hot water heating boilers, tanks and heaters. Illustrated with photos, also includes service recommendations. MacDonnell & Miller, Inc.

113 **Rotary Tube Cleaners**—Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and breakdowns special features. Also includes data on factory and how for use with cleaners. Bete Div., Elliott Co.

HEAT EXCHANGERS

114 **Lube Oil and Jacket Water Coolers**—Illustrated with many photos of complete assemblies, component parts and typical installations, this 24-pp catalog covers a heat exchanger design widely used for liquid to liquid heat transfer where working pressures and temperature ranges are moderate and fouling characteristics of fluids necessitate removable tube bundle units. Details construction of the coolers and provides full engineering data on two-pass and single-pass channel and bonnet types. Includes diagram of several floating head and removable bundle designs. Also discusses and pictures company's maintenance service. Condenser Service and Engineering Co., Inc.

115 **Converter Data**—Twelve-pp Bulletin 70 Section K is recommended because of the complete data included on company's U-tube type converter (hot water heater). Some 50 standard sizes are described with full dimensions and capacity ratings. Capacities are expressed for various steam pressures from 5 to 25 psi gage, and for nine temperature ranges covering high and low level ranges, the latter usual in radiant heat applications. Also includes pressure drop for each unit at rated capacity and data for determining pressure loss through each unit when operating at less than rated capacity. Installation diagrams, material specifications, data for determining steam requirements and pipe sizes are also provided. Davis Engineering Corp.

116 **Hot Water Heaters**—Catalog 325, 36-pp, provides typical piping arrangements, instructions for selection, dimensions etc. on manufacturer's two-, four- and six-pass instantaneous hot water heaters. Also contains data on condensate coolers, hot water service heaters, and gravity flow and booster heaters. Rock classifies heaters according to pounds of steam and is thumb-indexed for easy use. Patterson-Kelley Co., Inc.

VALVES

117 **Cylindrical Plug Valves**—Specification Sheet and 4-pp, provides engineering data on non-lubricated plug valves for manual or motor operation. Includes general specifications, sizes and mounting dimensions, also cutaway illustration of valve, and photo of an installation. Bellfield Valve Div., Minneapolis-Honeywell Regulator Co.

118 **Safety Valve Data**—Sizing safety valves for pressure reducing regulators are discussed and illustrated in Bulletin 200, 12-pp. Contains helpful test data and charts together with capacity tables of various models. Marine & Industrial Products Co.

INSTRUMENTS AND CONTROLS

119 **Pointer Draft Gages**—Bulletin 122, 12-pp, covers straight-line ball gages and dial ball gages. Describes these instruments, their design, ranges, mounting and applications. Illustrated with photos of gages and parts, mounting diagrams, operational sketches and draft curves. Includes dimensional data. Bilson Draft Gage Co., Inc.

120 **Pneumatic Controller**—An air-operated control system in combination with a strip chart recorder is the subject of 2-pp Supplement to Bulletin C3-1. Illustrated with photos, it describes the control equipment and explains how it functions. Wheelco Instruments Co.

121 **Program Controls**—Bulletin CM-1, 2-pp, describes automatic time-temperature program controllers. Includes a schematic drawing of a typical program, a listing of models, time cycle ranges, and prices. Wheelco Instruments Co.

PUMPS

122 **Centrifugal and Piston Pumps**—Catalog L is a 24-pp collection of engineering data on several types of volute pumps, duplex piston pumps, automatic feed pump and receiver, plunger pumps. Provides operating information, applications, dimensions, construction details and characteristics. Illustrations include photos of pumps, sectional sketches. Scranton Pump Div., Condenser Service & Engineering Co., Inc.

123 **Direct-Connected Pumps**—Bulletin 111, 4-pp, presents a direct-connected pump in capacities of 5 to 100 gpm for operating pressures up to 100 lb. Explains pump's principle of operation, mechanical features and includes photos of pumps and motor-driven, engine-driven and belt-driven pump units. Also provides full specifications. Blackmer Pump Co.

124 **Centrifugal Pumps**—Featuring a large cutaway illustration in color which shows design details and important operating features, Bulletin 382 presents centrifugal pumps for boiler feed and high pressure service adaptable to electric motor, steam turbine or engine drive. Discusses pumps' construction and possible modifications, includes approximate dimensions, photos of several models. American-Marsh Pumps, Inc.

MECHANICAL POWER TRANSMISSION

125 **Worm Gear Speed Reducers**—Illustrated Bulletin 125, 8-pp, presents two vertical speed reducers, one with gear shaft downward and the other with gear shaft upward. Provides complete dimensional data, cross section drawings, thrust and overhung load capacity charts on these and other vertical units. The Cleveland Worm & Gear Co.

126 **Tail Pulleys**—Bulletin 34, 4-pp, explains how company's specially designed tail pulleys can save wear and tear on conveyor and elevator belts, and includes testimonials covering several installations. Illustrated by photos, gives sizes and prices. Sprout-Waldron & Co., Inc.

MISCELLANEOUS

127 **Fire Hazard Index**—This 36-pp pocket-sized booklet lists, in quick-reference alphabetical order, over 500 chemical, gas and common fire hazard materials. Specifies which type of fire-fighting agent to use on each, as recommended by the Board of Fire Underwriters and the National Fire Protection Association. Also contains basic facts about the principles of fire-fighting in illustrated form. Available to qualified power engineers. Randolph Laboratories, Inc.

128 **Fuel Oil Treatment**—By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. Defines sludge and includes instructions for application of the fuel oil treatment. W. F. Drew & Co., Inc.

(Continued on page 200)

Use this CARD for information on ADS and NEW PRODUCTS also

APRIL, 1950
Card Void in 8 months

POWER GENERATION

Please have the manufacturers send me without obligation information or bulletins indicated by the following numbers.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Your Name _____

Your Title _____

Your Company Name _____

Company Address _____

City _____ State _____

(If you prefer delivery at your home also fill below)

Home Address _____

City _____ State _____

Also, use this card for more information on advertised products.

FIRST CLASS PERMIT No. 353
Sec. 34.9, P. L. & R.
CHICAGO, ILL.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed In the United States

4¢ POSTAGE WILL BE PAID BY—

POWER GENERATION

53 West Jackson Boulevard

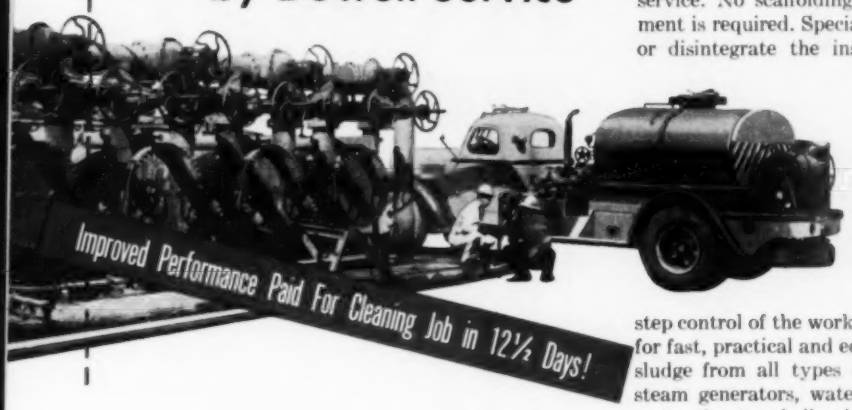
CHICAGO 4, ILLINOIS

DOWELL

SPECIALISTS IN SCALE AND SLUDGE REMOVAL WITH CHEMICALS

Condenser efficiency restored-

by Dowell Service



The water sides of fifteen tube and shell condensers in a West Texas refinery were almost plugged by heavy scale deposits. Dowell was called in to clean them. After a six hour soaking with specially selected Dowell solvents, they were flushed out and returned to service. Following this chemical cleaning, gasoline left the condensers 20°F cooler than after a previous mechanical cleaning. *The improvement in operating economy paid for the job in 12½ days!*

When you specify Dowell Chemical Scale Removal Service for your cleaning job, you get fast, convenient service. No scaffolding or dismantling of the equipment is required. Special solvents designed to dissolve or disintegrate the insulating scale are pumped in and out through existing connections. Costly down time is minimized.

Experienced Dowell engineers do the job. They bring the essential equipment — truck-mounted tanks, pumps, heaters, and chemical proportioners — to make possible step by step control of the work. Call the nearest Dowell office for fast, practical and economical removal of scale and sludge from all types of heat exchange equipment, steam generators, water lines and water wells. Free cost estimates gladly given.

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

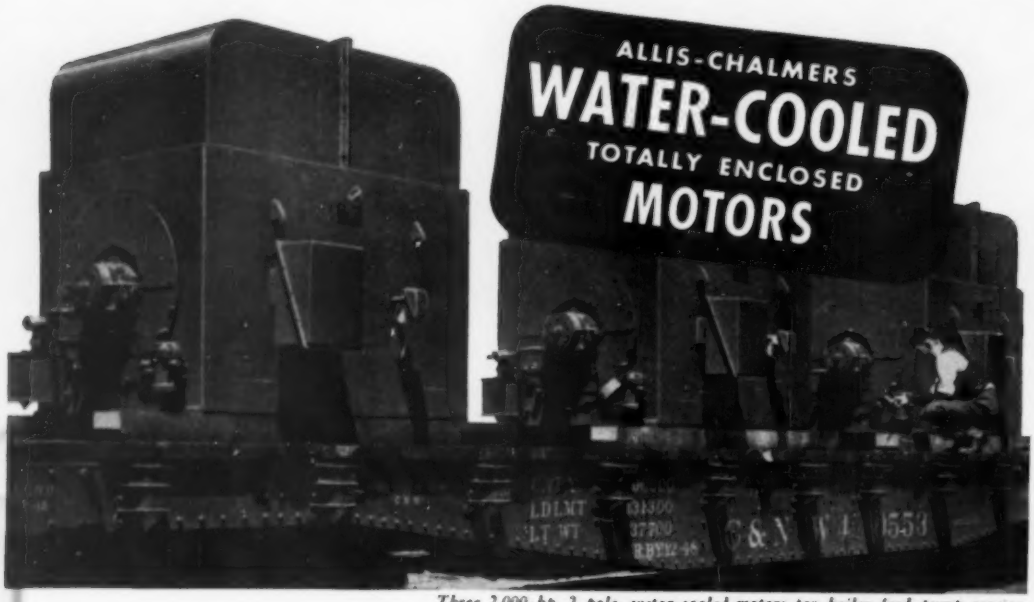
CALL

New York 20	Cleveland 13	Wichita 2	Hamilton, Ohio
Boston 16	Pittsburgh 19	Oklahoma City 2	Charleston 27, W. Va.
Philadelphia 2	Detroit 2	Houston 2	Salem, Illinois
Baltimore 18	Chicago 2	New Orleans 12	Borger, Texas
Wilmington 99	St. Louis 8	Ft. Worth 2	Midland, Texas
Richmond 19	Indianapolis	Shreveport 23	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.
Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.	

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

A SERVICE ORGANIZATION



Three 2,000-hp, 2 pole, water-cooled motors for boiler feed pump service.

DIRT-PROOF

COOLER Dissipate motor heat in water. Keep heat out of power-house.

QUIETER Lower sound level where unusually quiet motors are required.

AND Protect against dirt, corrosion and moisture. Permit outdoor installations.

YOU CAN PRACTICALLY ELIMINATE maintenance due to dust, dirt, fly ash, and moisture by using Allis-Chalmers water-cooled, totally enclosed construction for power plant auxiliary motors.

Place these protected motors outdoors or indoors, and you'll enjoy positive dirt protection. Indoors there'll be less heat in the power-house — especially in the summer time.

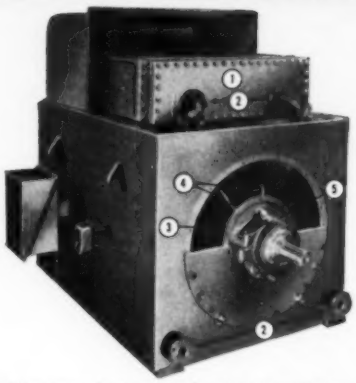
In addition, you'll find that this A-C ventilating and cooling system lowers the sound level.

Motors of this type can be provided for the larger power-house auxiliary drives. Size and weight are not appreciably increased over open motors of the same rating.

For complete information, outline your requirements to your nearby A-C Sales Office, or write direct. A-2973

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

WATER-COOLED MOTOR CONSTRUCTION



1. Air-to-water heat exchanger
2. Water connections
3. Rotor fan
4. Air pressure lines to bearing oil guard to prevent oil leakage into windings
5. Capsule type bearing

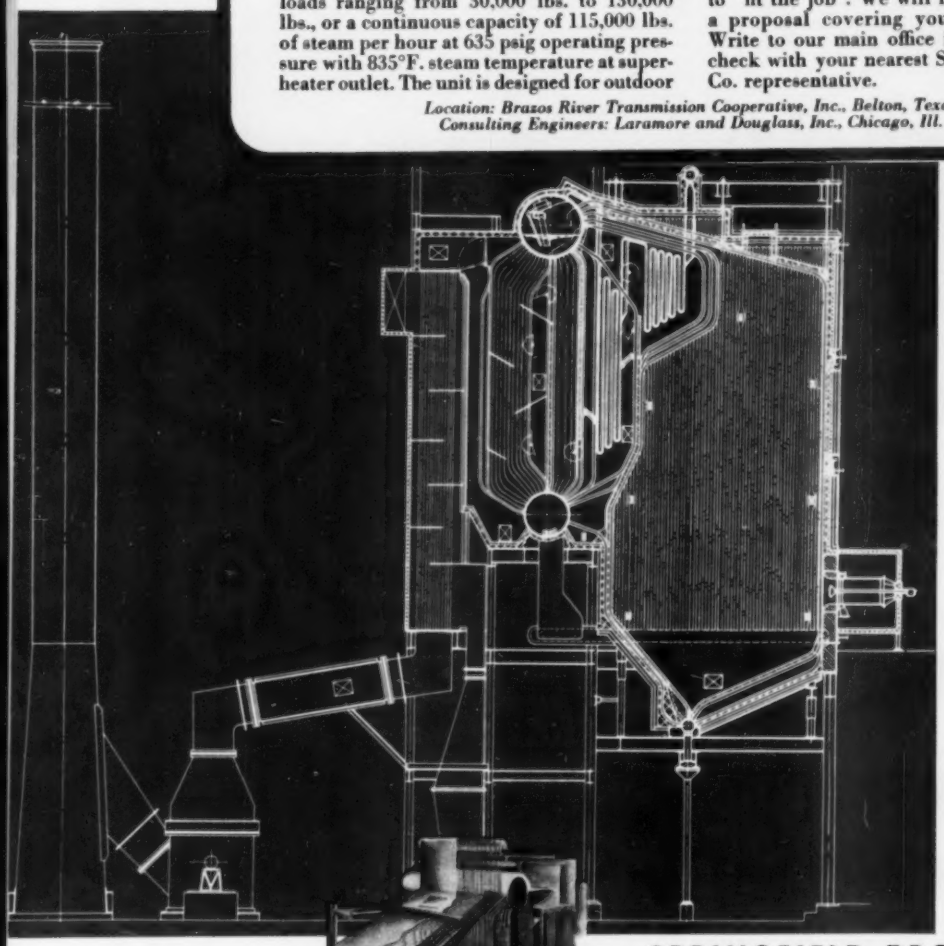
ALLIS-CHALMERS

More Power for TEXAS!

THIS new 2-drum steam generator is a typical example of the modern, economical units Springfield offers to meet user's particular requirements. It is designed to handle loads ranging from 30,000 lbs. to 130,000 lbs., or a continuous capacity of 115,000 lbs. of steam per hour at 635 psig operating pressure with 835°F. steam temperature at superheater outlet. The unit is designed for outdoor installation with a steel clad insulated setting and for firing with gas or oil, or in the future with pulverized lignite.

Springfield specializes in building boilers to "fit the job". We will be glad to submit a proposal covering your requirements. Write to our main office in Springfield, or check with your nearest Springfield Boiler Co. representative.

Location: Brazos River Transmission Cooperative, Inc., Belton, Texas
Consulting Engineers: Laramore and Douglass, Inc., Chicago, Ill.



SPRINGFIELD BOILERS

CHECK WITH YOUR CONSULTING ENGINEER ON YOUR MODERNIZATION AND NEW PLANT PROJECTS

SPRINGFIELD PRODUCTS

BENT TUBE STEAM GENERATORS—Modern designs for capacities from 10,000 lbs. up.
STRAIGHT TUBE BOILERS—Specially designed for capacities from 5,000 to 450,000 lbs. per hour and higher.
STANDARDIZED TYPE MC BOILERS—Standardized for quicker delivery and lower cost. Sizes 7,500 to 17,800 lbs. per hour.
WATER COOLED FURNACES—Heavy duty water walls. Exclusive center water wall construction for larger units.
SUPERHEATERS — AIR HEATERS — ECONOMIZERS — Individually designed to meet requirements.

See our catalog in SWEET'S

SPRINGFIELD BOILER CO.

1951 E. Capitol Ave., Springfield, Illinois

WORLDWIDE SALES AND SERVICE

NEW YORK • PHILADELPHIA • WASHINGTON, D.C. • DETROIT • KANSAS CITY • HOUSTON
CHICAGO • ST. LOUIS • ST. PAUL • PORTLAND, ORE. • Export: READING, PA.

(Partial view of the enormous new lubricating oil plant at Lake Charles, La., where this great new oil is processed.)

"ANTI-FOULING" OIL made by the Remarkable new "HEART-CUT" PROCESS

This new oil—the best known to science... gives you a cleaner engine...more economy ...minimum carbon residue.

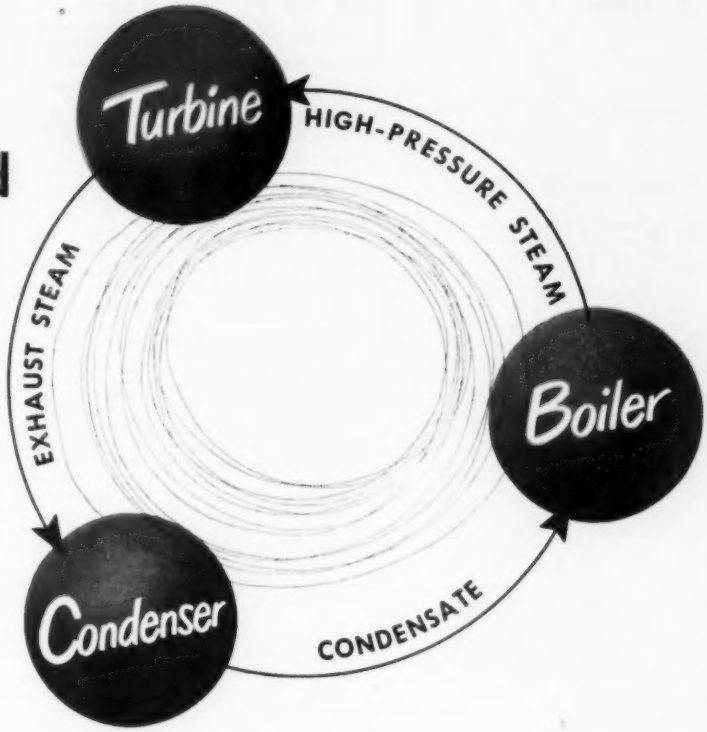
It's here now! The remarkable motor oil from the giant new $42,000,000 lubricating oil plant at Lake Charles, La. The plant that's been the big talk of the oil industry for months.

New Premium Koolmotor is made by the unique "Heart-Cut" Process which retains only the choicest part of the finest crudes. *It's so superior that in recent engine tests it outscored nine other major premium motor oils.* No wonder Premium Koolmotor is better in every way! Cleans better, seals better, cools better and fights acid, sludge and corrosion far more effectively. Switch to this remarkable new oil today.

start saving Dollars today...stop at

CITIES SERVICE

Merry-go-round with many problems



THE problems involved in steam generation, steam use, and the subsequent condensation of steam into water are complex and difficult, presenting an almost infinite variety of intricate cross-relationships.

The correct solution of these problems is, however, imperative, for the availability of a boiler depends directly on the proper water treatment and the care and precision with which prescribed procedures are carried out.

Hall Laboratories not only understands these problems but knows their implications in terms of plant construction and operation, and of plant personnel. Hall knows, too, that the answer must ultimately be in terms of dollars and cents.

In these, and in all other problems relating to the industrial use of water, Hall Laboratories is prepared to recommend procedures which, taking all factors into account, represent the most economic and efficient solution *in your specific situation.*

May we send you a copy of the new Hall bulletin "Your Most Important Raw Material"? Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL *plant-wide* WATER SERVICE

BOILER WATER CONDITIONING

PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

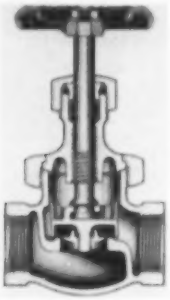
NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—GAS VALVES

Globe, angle and check types for liquefied petroleum-gas service

These valves have been tested and approved by Underwriters' Laboratories, for use on liquid petroleum-gas up to a maximum of 250 psi, company states, and all three types have screwed ends and come in sizes from ¼ to 2 in. To provide for tight seating, the valves have company's No. 6 composition disc



cemented into the disc holder. Tightness at the stuffing box is credited to one-piece molded asbestos packing a stuffing box of liberal dimensions.

The valves are also recommended for hot or cold water, compressed air, gasoline, light oils, and other services requiring sturdy, tight valves within their pressure-temperature ranges. Crane Co.

2—WATER HARDNESS TESTS

Are titration processes using color indicating solutions

Total water hardness and that caused by calcium alone can be measured in approximately 1 min., according to company. The Hagan Total Water Hardness Test involves a simple, direct titration with a distinct color change at the end point. Also of practical advantage, it is pointed out, is that interferences, although seldom found, are easily eliminated.

The calcium test is also a direct titration to a clear-cut color change and the answer is claimed to be correct to less than 1 ppm. When hardness due to magnesium in water is to be determined, the operator makes the total hardness test and the calcium test, the difference giving him the magnesium value.

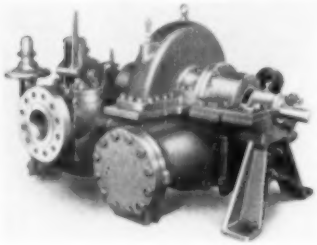
In testing, a sample of the water is measured into a porcelain dish and a small amount of buffer solution stirred in to bring sample to suitable pH value. The indicating solution then is added and stirred, sample at this point showing a red color. When titrating solution is added it turns color to blue. Disappearance of last trace of reddish tinge marks end point. Procedure for hardness due to calcium is identical with different solutions and final color a violet blue. Hall Laboratories, Inc.

3—SINGLE-STAGE TURBINE

Is standard type designed especially for high pressure service

The CP Turbine intended for initial pressures to 1450 psig, initial temperatures to 950 Ftt and back pressures to 300 psig. It is described as the first single stage, mechanical drive turbine with all labyrinth shaft seals, provided to prevent leakage, last longer and require less maintenance.

To provide for extreme thermal expansion encountered in high temperature service, the turbine is supported at the true centerline and the front end mounted on a flexible channel. Com-



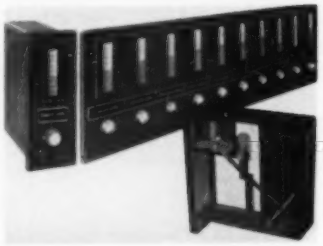
pany says this method of mounting permits both radial and axial expansion without disturbing the shaft centerline.

Turbine can be furnished with any of eight governor types including mechanical shaft, vertical flyweight with or without oil relay, pressure governors for pump and blower drives and auxiliary tripping devices. A separate trip operating independently of governing system is provided for protection against overspeeding. Tubine is available in three sizes for capacities up to 2000 hp. DeLaval Steam Turbine Co.

4—LEVEL INDICATORS

Are made with direct-reading graduated illuminated dials

Operating from any 3 to 15 lb pneumatic transmitter or direct from valve loading pressure, a sensitive and accurate reading of liquid levels can be transmitted any distance to this new level indicator receiver, company explains. Changes in levels from any



source, from any remote point, are visually reproduced on the dial. A solid red band on this translucent dial depicts any dip and rise in levels.

Indicator has drawer type assembly unit for convenience in removing mechanism for inspection. Zero settings and adjustments are positioned externally at back of gage. Gages may be provided with positive high and low level mercury alarm switches, wired in a series with company's hermetically sealed Panalarm signalling unit. Panalarm Products Div., Panellit, Inc.

5—AIR HOSE

With the tube and rubber made of oil-resistant rubber compounds

The improved Type 22 Air Hose has three-ply fabric reinforcement and is made with a smooth finish red cover with extra toughness to resist weathering and sun checking. Strong adhesion of cover to carcass enables hose to withstand repeated bending and flexing with less danger of separation, according to manufacturer, and the tube of the hose will not flake off to plug attachments or tools.

Besides its primary purpose, this air hose is recommended for other applications including handling petroleum solvents and lubricating oils. It is made in ¼, 5/16, and ⅜ in. sizes. Outside diameters are ½, 9/16, and 21/32 in. and weight per 100 ft is 10.3, 12.2 and 15.1 lb. The two smaller sizes withstand 150 lb working pressure and the larger 125 lb. The B. F. Goodrich Co.

6—DOUBLE ROTOR CRUSHER

For economical handling of many materials, including wet coal

The S-A Double Rotor Knittel Crusher is equipped with two rotors driven by separate, direct coupled motors. Synchronization is unnecessary, company points out, because the crushing sections on the rotors operate independently, first splitting the coal on initial impact and then crushing it on the breaker plates. Sized slots in the

USE THE NO-OBLIGATION, POSTAGE-PAID CARD ON PAGES 35-36

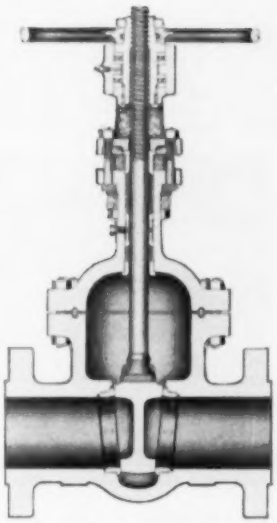
For the best in power piping...
Look to the complete CRANE line

STEEL VALVES FOR GENERAL STEAM SERVICES

You can count on Crane Cast Steel Wedge Gate Valves for dependable performance under the most severe service conditions. Straight-through ports minimize turbulence, erosion and resistance to flow. Long, close-fitting disc guides assure tight seating.

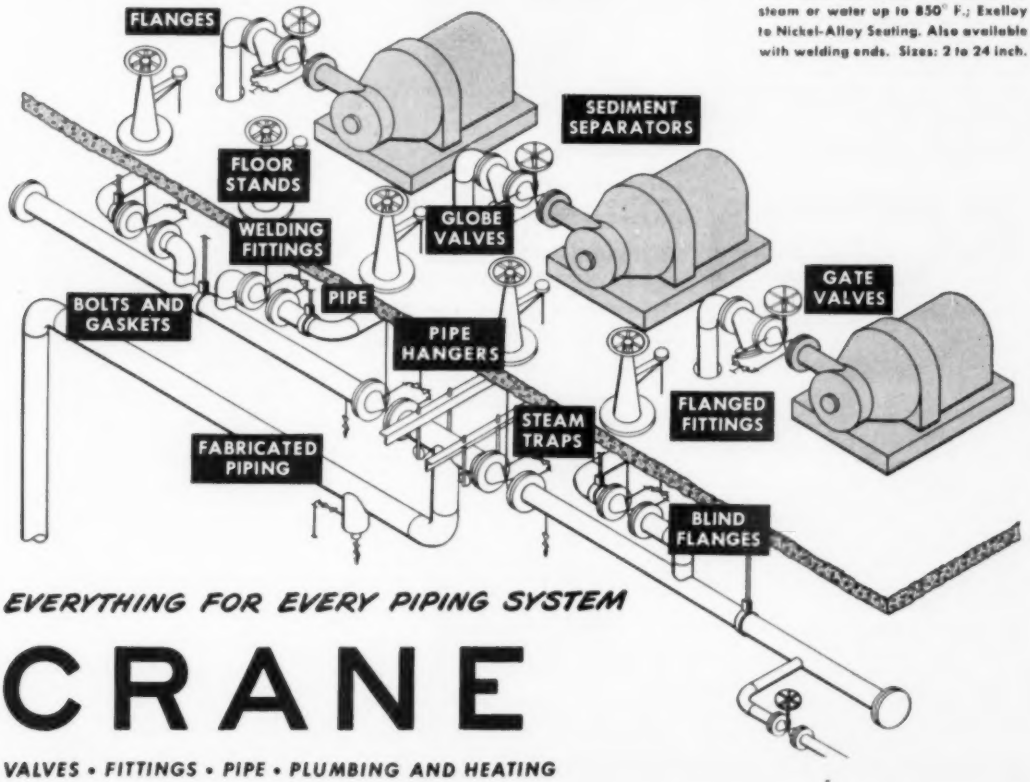
Strong tee-head disc-stem connection, easily lubricated yoke bushing, and ample bearings provide smooth operation. Made of Carbon or Alloy Steel suitably trimmed for pressures and temperatures up to 2500 pounds at 1000° F. Available with flanged, screwed, or welding ends. See your new No. 49 Crane Catalog.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



No. 76XR, 600-Pound Steel Gate. For steam or water up to 850° F.; Exelloy to Nickel-Alloy Seating. Also available with welding ends. Sizes: 2 to 24 inch.

THIS STEAM TURBINE PIPING INSTALLATION CAN BE 100% CRANE ON ONE PURCHASE ORDER



EVERYTHING FOR EVERY PIPING SYSTEM

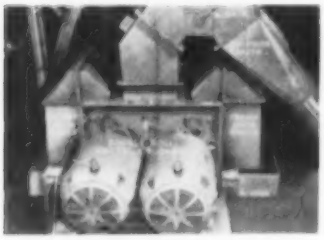
CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

crusher grate bars determine maximum size of material.

It is explained that the triangular sections are held in position only by centrifugal force; they are free to adjust position on impact with tramp iron, or other foreign material. Hinged fingers

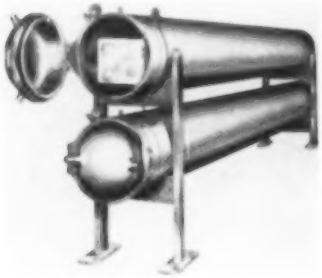


on each side of the crusher allow the sectors to bat tramp iron out without damage to crusher. Large feed openings and the use of only two gangs on each rotor are intended to allow maximum size lumps to be handled. Stephens-Adamson Mfg. Co.

7—DRY ICE CONVERTERS

Offer convenient, permanent CO_2 gas supply for industrial processes

Full 50-lb commercial blocks of dry ice may be charged into this full-opening converter to eliminate frequent gas cylinder reshipment. Converters are available in 300, 600, 750 and 1,000-lb dry ice capacities. The largest size stores approximately 8700 cu ft of CO_2



gas which can be withdrawn at rates up to 850 to 900 cu ft per hr. Liquid CO_2 may also be withdrawn, company states.

Converters are built to ASME specifications and special racks are available for vertical or horizontal mounting in accordance with space requirements. Dry Ice Converter Corp.

8—RE-ENTRY TYPE PUMPS

Are combination of primary and secondary pumps built in one unit

These pumping units are said to greatly reduce installation space without introducing unusual maintenance problems and to provide savings in first costs because of space-saving design and the elimination of several parts per unit.

In a recent installation of these pumps, the discharge pressure is 1570 psi and total capacity is 1980 gpm. The pumps are driven by 2025 hp steam turbines turning at 5000 rpm. In the primary section, the water is pumped at 255 F. In the secondary the water is pumped at 465 F.

Construction of these units eliminates one set of bearings, one set of stuffing boxes, and one driver. Part of the preheating is accomplished between primary and secondary sections, an arrangement allowing use of low-pressure heaters. Byron Jackson Pump Div.

9—ELECTRICAL ANEMOMETER

With built-in temperature compensating probe to offset errors

The Model G Air-Meter, designed to provide instantaneous, direct and accurate readings of air velocities from 5 to 6000 fpm with an expanded scale in the low ranges, is now available with compensation to prevent momentary error in velocity reading when probe is subjected to sudden changes of temperature.

Available accessories include a carrying case with battery operated power pack for use when 110 v a-c power supply is not available. Hastings Instrument Co.

10—ELEVATING PLATFORM

For positioning light loads up to 36 in. above floor, works by air pressure

This platform is designed to use standard air pressure of 90 to 100 lb for lifting capacities up to 300 lb. Its 30 by

30 in. platform lowers to 6 in., and elevates to 42 in. A packaged unit, it is intended for simple installation below floor level and requires standard hookup to user's air pressure system.

Foot or hand-operated valves can be furnished. Platform has a stop to prevent top from turning, and can be designed to turn 360 deg or lock in fixed positions. Ranges of elevation up to 36 in. available. Lyon-Raymond Corp.

11—VINYL RESIN PRIMER

For pretreatment of metal scheduled for water-submerged service

This primer is intended to inhibit corrosion temporarily prior to finish coating, and to give surfacing material improved bonding and greater durability. This vinyl formulation is said to meet the requirements of water immersion service and is recommended for use (in combination with company's Apexior No. 3 as a surfacing material) in water-storage tanks, condensers, locomotive tender cisterns and wherever metal is exposed to fresh or salt water at temperatures to 140 F.

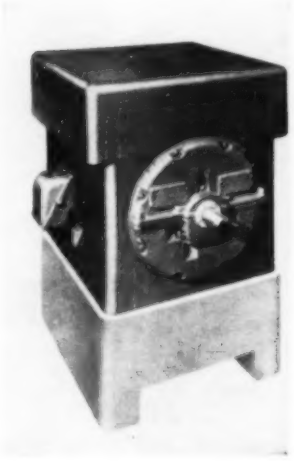
Primer is applied by brush or spray to any type of clean metal. Only one coat is required, as recommended coverage is less than tissue-paper thickness, and a gallon is intended to protect from 800 to 1000 sq ft. The applied film dries ready for finish coat in 30 min., company says, but if final surfacing is to be delayed, the film is resistant to sub-freezing temperatures, mid-summer heat, and high humidity and heavy rain. The Dampney Co. of America.

12—BASE-VENTILATED MOTOR

For driving power station auxiliaries mounted out of doors

Available in ratings ranging from 200 to 3000 hp, this motor was developed for those outdoor installations where totally enclosed fan-cooled units are not available.

The motor is intended to be mounted on a concrete base raised sufficiently from the ground to allow contaminated



ambient air to flow through the foundation at high velocity. Ventilating air enters motor through a vertical passage in the base, and is pulled from the ambient air stream at low velocity. At such a low velocity, almost no water or foreign matter can be carried up into motor, it is said. However, baffles

STEAM PLANTS

FROM BAILEY CONTROLS

1. Get More Steam Per Dollar

Save on fuel
Save on maintenance
Save on power for auxiliaries

2. Deliver Better Power Service

Reduce forced outages
Increase unit capacity
Maintain steam pressure on load swings
Insure adequate process steam
Prevent steam waste

3. Insure Safer Operation

Reduce explosion hazard
Free operators to check any sign of trouble
Prevent excessive steam temperatures
Prevent water carryover and low water
Protect feed pumps at low rates

Application to Your Plant

If you would like to have this 3-way profit of money saving, improved power service, and greater safety for your plant, call on your local Bailey Engineer. He will analyze your layout and make recommendations. He is in a position to help you secure the 3-way profit which results from the intelligent use of correctly selected and properly coordinated steam plant controls.

BAILEY METER COMPANY

1040 IVANHOE ROAD • • • CLEVELAND 10, OHIO

Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

are fabricated within air intake passage to eliminate even small amounts of foreign matter.

After circulating through motor, ventilating air is exhausted through protected ports in top. In case air enters exhaust ports during a heavy storm, adequate elimination and drainage are provided, it is pointed out. If air has a high cinder content, a coarse screen may be added to base for further protection. General Electric Co.

13—TEMPERATURE CONTROLLER

Is self contained unit incorporating electric proportional control

This is described as a self-operating unitized control unit, accurate, flexible and easy to install. It is designed to measure temperature by means of a remote bulb thermal system and electrically operate its motor driven control valve to maintain desired temperature of tanks, ovens, heaters, kettles and the like, as well as refrigerating, heating and air conditioning units.

Controller has temperature range selection from 0 to 700 F, with external calibrated control point setting scale graduated in degrees Fahrenheit or Centigrade. Control valve sizes are ¼ to 6 in. Costs start at $75.00. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

14—SELENIUM RECTIFIERS

In single- and three-phase types for use with d-c operated equipment

The 2 S Series Selenium Rectifiers are available in six classes, which include combinations of normal convection cooling, fan cooling, auto transformers, and double wound transformers. D-c output voltages are 115 v or 230 v, in capacities of from 57 w to 80 kw. Dual a-c inputs are 115/230 v or 230/460 v; single voltage a-c inputs are 208, 230 or 460 v.

All of these rectifiers incorporate selenium rectifying element, full wave bridge, circuit, ebony panelboard, and thermal protection. Lower capacity units are housed in 16 gage louvered wall mounting cabinets with conduit knockouts and cast aluminum transformer domes. Cubicles for larger-capacity rectifiers are heavy floor mounting type. Accurate Engineering Co.

15—FLEXIBLE COUPLING

Is designed for ease of installation, larger bore capacities

The L-R Type C and H Couplings are intended for use on motor-driven or engine-driven pumps, compressors, generators, pulverizers and almost all machinery of 50 to 1000 hp. Heavy models are electric cast steel.

In these couplings, the inside sleeve is made in two parts, instead of one—providing a sleeve in each body. Both bodies are machined alike for the removable steel collar. This is to facilitate putting collar on either half of the

coupling. Collar is held by a snap ring.

Couplings are designed to adjust for misalignment, shock, vibration, oscillation, surge or backlash. Also, half of the cushions are idlers, so there is always a set of new cushions in the coupling. The couplings are available with several cushion materials to suit different services from 1/6 to 2500 hp. Lovejoy Flexible Coupling Co.

16—LUBRICATING ADDITIVE

Is intended to boost lubricity and performance life of oils

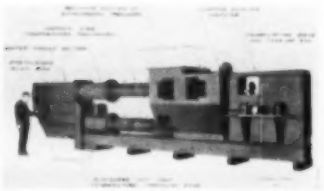
This additive, described as friction-proof, is said to prolong the life and increase the efficiency of diesel, gasoline and electric motors and engines as well as pistons, gears, bearings, cutting tools and moving machine parts. Other features credited to it are rust-proofing, detergent, and penetrating properties.

According to manufacturer, the additive is non-corrosive, non-acid forming and non-injurious to any metal. When used with oil or grease it forms a microscopic but tough lubricating film that penetrates into the metal and protects the surface from corrosion as well as scuffing and scoring, company explains. Power Ball Oil Co., Inc.

17—COAL FEEDER

Offers variable speed for close control volumetric feeding

This feeder is intended for conveying coal at controlled rate without pulsation into furnace against both heat and pressure. It handles 35,000 lb of coal per hour from weigh scale to furnace hopper by means of a chain and circular flight assembly. The unit consists of drive and take-up, receiving section,



pneumatrol, water cooling section and idler box.

The pneumatrols enable conveyor circuit to handle coal from an atmospheric pressure zone to a zone above atmospheric, it is explained. Coal is discharged from the idler box into the furnace hopper. Air under pressure is introduced into this hopper through ducts and the coal is fed directly into the air stream. Idler box has a vibrating plate feeder made with controls outside the pressure zone and its use is intended to permit an even coal flow to boiler, eliminating feed pulsation.

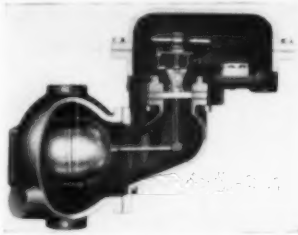
The receiving section is engineered to allow coal to be fed to chain and flight assembly so voids between flights will be uniformly filled even though coal is wet. Both return and carry runs of the chain go through the receiving hopper. Hapman Conveyors, Inc.

18—ELECTRIC CONTROLLER

For water tanks, receivers and other liquid storage systems

The No. 65 Controller is described as a float-operated electric type designed for use under conditions where many types of controllers are not applicable. It can be used to "make" or "break" electrical circuits at either high or low levels—for controlling motors, signal lamps, electrical elements.

According to manufacturer, the No. 65 is Underwriters' approved for atmospheres containing ethyl-ether vapors, ethylene or cyclopropane, and for



atmospheres containing gasoline, petroleum, naphtha, benzine, butane, propane, alcohols, acetone, benzol, solvent vapors or natural gas. It is furnished with a standard switch that breaks circuit with falling liquid level, but a reverse acting switch is available. Float chamber is heavy cast iron, float is copper, float rod is brass and bellows are bronze. Maximum body pressure is 40 lb. McDonnell & Miller, Inc.

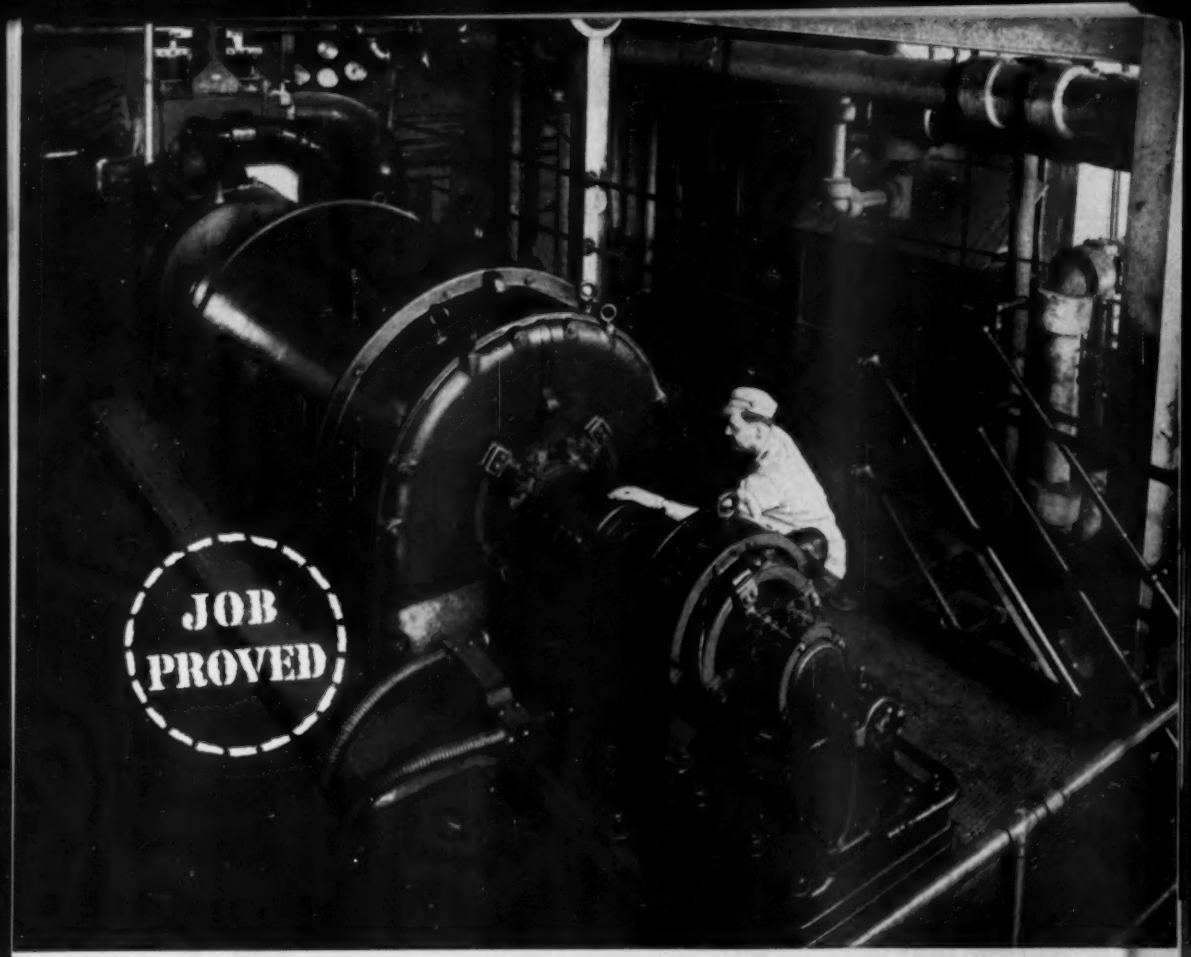
19—PLATFORM HOIST

Is designed for maintenance and inspection work at all elevations

The Bosun's Chair is a rigid tubular steel cage moved by a winch. Sitting on a bicycle-type saddle having two coil springs, the worker operates standard bicycle pedals to raise or lower hoist. Seat height is adjustable, and it's also possible to work from a standing position.

Power is transmitted from pedal crank to winch drum by roller chain, running on sprocket wheels. Movement of hoist in either direction may be as fast as 25 ft per min, under control of operator. With a rated capacity of 625 lb, this hoist is furnished with 150 ft of ¼ in. 6 by 19 plow steel wire rope. Weighing only 75 lb, it is intended for one-man operation and quick rigging.

Hard rubber rollers on the front of



PROTECTED BY SUNVIS 916

Turbine Bearings and Journals Corrosion-Free Despite Summer Shutdowns — Oils Like New After 9,000 Hours

Three years ago, a paper mill overhauled a steam turbine. Thereafter, it was planned to operate this equipment on a 'round-the-clock schedule during the six winter months, and completely shut down in the summer. On the advice of a Sun Engineer, the mill charged the circulating system supplying turbine, generator journals, and governor with Sunvis 916. This oil was chosen because of its "Job Proved" ability to prevent rust and corrosion and to give troublefree lubrication for a long period of time.

The management's selection of Sunvis 916 proved to be sound. After 9,000 hours, a laboratory analysis of the oil showed it to be unchanged—comparable to a sample of new oil. Even more important, inspection showed no abnormal wear and no corrosion in bearings and journals, despite the summer-long shutdown.

The turbine has now operated 12,000 hours without oil-change, and it appears that none will be necessary in the foreseeable future.

All oils in the Sunvis 900 series have a high viscosity index, are fortified against oxidation and sludging, and prevent rust and corrosion. Sunvis 900 Oils are the finest lubricants available for turbines, hydraulic systems, and similar applications. For a free, illustrated booklet on Sunvis 900 Oils, write Department PN-4.

SUN OIL COMPANY • *Philadelphia 3, Pa.*
In Canada: Sun Oil Company, Ltd.
Toronto and Montreal

SUN PETROLEUM PRODUCTS
"JOB PROVED" IN EVERY INDUSTRY

SUNOCO

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

the unit are provided to prevent marring of working surfaces and make it easier to raise or lower the hoist, and

these rollers can be tilted to fit cylindrical surfaces, company points out. Safway Steel Products, Inc.

20—MOLDING COMPOUND

Consists of a silicone resin and a glass fiber filler

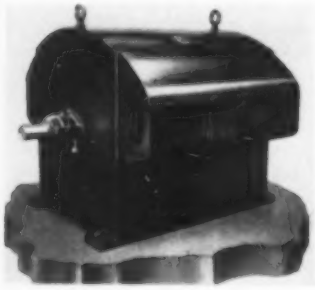
Outstanding heat resistance is said to be the principal feature of this new material. It is intended to withstand continuous operation at 392 F, and to have high impact resistance, excellent arc resistance and good flow in the mold. It will not support combustion and tests show it has no toxicity when burned, company reports.

It is described as ideally suited for circuit breakers, switchgear and other parts where resistance to extreme heat and impact is necessary. Chemical Department, General Electric Co.

21—SPLASH-PROOF MOTOR

For outdoor steam generating stations, open air process plants

Built in sizes from 150 to 2000 hp, 4 to 14 poles, this motor has a ventilating system with straight-through inlet and discharge openings on both ends for protection from all directions against wind-driven rain. Foreign



matter blown into ventilating openings is deflected by a series of baffles, company explains, and either drains out or travels straight through exterior ventilating system and out the other side without entering interior of motor.

Stator coils are vacuum-pressure impregnated, and have a mica wrapper on their slot portion for 2300 v and higher Class A insulation. Completed stator is soaked in moisture-resisting varnish and baked to provide moisture resistant seal. The foundation for this motor may be a simple, economical concrete slab. Either sealed, split, ring-oiled, sleeve or antifriction bearings are available. Ridgway Div., Elliott Co.

22—FLEXIBLE STAINLESS HOSE

Is available in wide range of sizes and wall thicknesses

This steel hose is intended to withstand high temperatures and pressures and is recommended for conveying corrosive or searching liquids and gases where motion is required. Extreme flexibility permits it to withstand extreme cycles of vibration, flexation and variplane motions, it is reported. For constant flexing or continuing motion a hose with closed corrugation pitch is recommended; and for infrequent flexing, misalignment or slight movement, an open corrugation pitch.

Hose is fabricated in sizes from 5/16 through 6 in. ID in one or multiple-ply construction. Available with helical or annular corrugations, with or without braid covering, depending on service requirements. Wall thicknesses from 0.003 in. in single ply to 0.030 in. in multiple-ply construction; working pressures to 2000 psi. Standard pipe fittings or special fittings may be attached by silver brazing or welding. Chicago Metal Hose Corp.

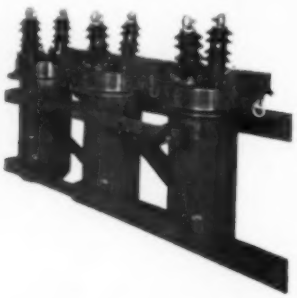
23—AUTOMATIC RECLOSER

Is three-phase type with maximum service ratings of 100 amp, 15,000 v

The Type FR Recloser is primarily designed for rural distribution systems, and has a short circuit interrupting capacity of 3000 amp. It is described as offering safer operation and easier maintenance. Its construction combines three single-phase reclosers in a single unit.

The new units employ a common linkage intended to assure positive operation in locking-out all three phases whenever a permanent fault occurs. When fault is cleared, a single resetting operation may then close all three circuits. However, it is explained that the three units operate as single-phase reclosers when an intermittent fault occurs.

Constructed to use three separate tanks, the possibility of phase to phase



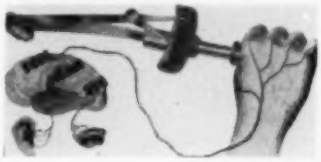
failure is reduced, company points out, and service continuity is improved. Apparatus Dept., General Electric Co.

24—TORQUE WRENCHES

Are engineered for control by feeling, sound and sight

In the high-speed Proto Torque Wrenches a trip lever is set at the desired torque reading, and when the wrench is pulled to this exact reading the lever trips a signal trigger. At this instant, company explains, a definite impulse is imparted to the hand and a loud click is sounded. The resulting sensations of feeling and sound are intended to cause the operator to release the wrench at desired torque setting. The operator may also watch a dial.

This type of wrench is said to eliminate strains, breakage, binding, loosen-

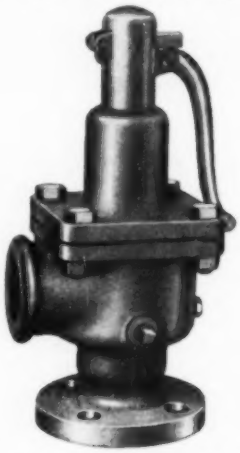


ing, stripped threads of nuts, bolts and threaded parts. With the three methods of control available, an operator can work in bad light, in noisy places, company points out. Wrenches have a sturdy, one-piece flat beam. Available in twelve sizes: six have capacity limits from 25 to 300 ft-lb, and six from 300 to 3600 in.-lb. Plomb Tool Co.

25—SAFETY AND RELIEF VALVES

Are available in cast carbon steel and alloy-steel materials

These valves represent an addition to company's line of bronze valves of this type. A typical valve in the new line is cast carbon steel with stainless steel trim for pressures up to 600 lb., tem-



peratures to 650 F, sizes ¾ to 6 in. ASA standard flanged inlet and flanged or screwed outlet. The valve is a Navy approved adaptation with high discharge capacity and close blowdown control, according to manufacturer, Kunkle Valve Co.

26—ELECTRIC CONTROL

Responds to flow of cold water to open or close electrical contact

Called a flow interlock, this device measures approximately 2½ by 3 by 7 in. It closes a contact when a flow

DEARBORN POLYAMIDE ANTI-FOAMS REDUCE FOAMING, KEEP VITAL STEAM LINES CLEAN

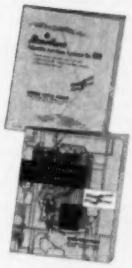
These are unretouched photographs of cutaway sections of superheater tubes. The bend at the left has a heavy scale deposit—the result of incompletely treated boiler water. The bend at the right was kept free from scale because the boiler water was treated with Dearborn Polyamide Anti-Foam 659.

This recent Dearborn development reduces foaming . . . prevents carry-over and consequent deposits of scale which may foul superheater tubes, turbine blades, valves and cylinders . . . conditions sludge . . . is compatible with other boiler water treatment.

If you use steam—in the operation of your plant or in the manufacture of your product—it will be worth your while to investigate Dearborn Polyamide Anti-Foam and other Dearborn water treatment service. The broad experience of Dearborn . . . gained by serving industry since 1887 . . . is immediately available to you.

DEARBORN CHEMICAL COMPANY
General Offices: 310 South Michigan Avenue • Chicago 4, Illinois

WRITE FOR COPIES OF THESE TWO VALUABLE BOOKLETS



For full information on Dearborn Polyamide Anti-Foams, write for Bulletin No. 5008. And for the story of Dearborn Industrial Water Treatment and Engineering Service, write for Bulletin No. 5000. The coupon is for your convenience.

DEARBORN CHEMICAL COMPANY
Dept. PG, 310 S. Michigan Ave., Chicago 4, Ill.
Gentlemen: Please send:
☐ Bulletin No. 5008—Dearborn Polyamide Anti-Foams
☐ Bulletin No. 5000—Dearborn Industrial Water Treatment and Engineering Service.

Name.....
Company.....
Position.....
Address.....
City.....*State*.....

Dearborn
TRADE MARK REGISTERED
THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

Mark the numbers of the items you wish to receive on the no-obligation, no postage card. Pages 35-36.

of water exceeds a preset amount and opens it when the flow falls below the preset amount, manufacturer explains. Working on this principle, it is said to act as a fuse in a circuit which depends on water cooling for protection.

Comes with union fitting and strainer arrangement. Designed to operate for the amount of flow independent of pressure, the interlock is intended only for cold-water applications. Electrical rating is 10 amp at 125 v, 5 amp at 250 v, and 3 amp at 460 v, all a-c. Maximum line pressure tolerated is 125 psi. Control Divs., General Electric Co.

27—SMALL SPEED CHANGERS

Are engineered for gear reductions as high as 750,000 to 1

These miniature speed changers are made up by adding one or two additional gearing sections to company's standard three-section units having ratios up to 3375 to 1. This is intended to provide several hundred ratios between 1000 to 1, and 750,000 to 1, in addition to (500 or more) standard 1, 2 and 3 section units.

Input speeds as high as 50,000 rpm, and output torques up to 2 lb-in. are permissible, company states, and very high ratios in hobbed gears and "zero backlash" construction can be furnished at reduced torque rating. Weights of 4 and 5 section units are approximately 6 and 7 oz. Body diameter is 1.050 in.; lengths are 3-15/16 in. for 4 section unit and 4¾ in. for 5 section units. Metron Instrument Corp.

POWER PLANT *Construction News*

Chickasaw, Ala.—Alabama Power Co., Birmingham, Ala., has plans under way for expansion in steam-electric generating station at Chickasaw, near Mobile, with installation of new 40,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. No estimate of cost announced. This will be part of 1950 extension and improvement program of company.

Ozark, Ark.—Arkansas Valley Electric Cooperative Corp., Ozark, has negotiations under way for REA for approval and financing for a proposed new steam-electric plant on site near Ozark. Cost estimated about $9,500,000, with turbine-generators, high-pressure boilers and auxiliary equipment for large capacity. W. M. Milton is manager.

Windsor Locks, Conn.—Windsor Locks Canal Co., Windsor Locks, plans new hydro-electric generating station on Connecticut River in Hartford County, with initial installation to consist of four hydraulic turbines and electric generators, with total rating of 42,000-kw. No estimate of cost announced. Application for permission has been made to Federal Power Commission. Company is a subsidiary of Connecticut Light & Power Co., Hartford, Conn.

Miami, Fla.—Florida Power & Light Co., 25 South Second St., is reported planning new steam-electric generating station to cost about $6,000,000, with turbine-generators, high-pressure boilers and accessories. Project will include switching station and transmission line extensions.

Hartwell, Ga.—Monroe Auto Equipment Co., East First St., Monroe, Mich., truck platforms, skids and other equipment for shipping new automobiles, plans boiler plant at proposed branch factory at Hartwell, where tract of land is being selected. Entire project is reported to cost over $2,000,000.

Kansas City, Kan.—International Harvester Co., 180 North Michigan Ave., Chicago, Ill., motor trucks, agricultural machinery, etc., plans boiler house in connection with new factory branch, storage and distributing plant at McCormick and Sunshine Rds., Kansas City, where tract of land has been secured. Project will comprise two main one-story buildings, 530 x 618 ft, and 372 x 500 ft, respectively, and is reported to cost about $5,000,000. Robert E. Hattis, 223 West Jackson Blvd., Chicago, is mechanical engineer; Fred V. Prather, 8 South Michigan Ave., Chicago, is architect.

Egan, La.—Sun Oil Co., Meraux St., New Orleans, La., plans steam-generating station and compressor plant in connection with proposed new natural gasoline plant in vicinity of Egan. Processing and other equipment will be installed for large daily output. Cost reported over $2,500,000. Proposed to begin work soon. Main offices of company are at 1608 Walnut St., Philadelphia, Pa.

Crownsville, Md.—State Department of Public Improvements, 210 East Lexington St., Baltimore, Md., has authorized plans for new boiler house at State Hospital, Crownsville, for central-heating service at institution. Cost reported about $500,000, with boilers and auxiliary equipment. Bids will be asked in near future. Turpin, Wachter & Associates, 1004 North Charles St., Baltimore, are engineers.

Tewksbury, Mass.—Department of Public Welfare, Commonwealth of Massachusetts, 600 Washington St., Boston, Mass., has plans under way for extensions and improvements in steam-electric power plant at institution at Tewksbury. Cost reported about $100,000, including generator unit and accessories.

Lapeer, Mich.—State Building and Construction Division, State Capitol, Lansing, Mich., has plans nearing completion for extensions and improvements in boiler plant at State Home and Training School, Lapeer, including installation of boilers, combustion control apparatus, induced draft fans, dust collectors and miscellaneous equipment. Cost reported about $250,000. E. R. Little, Inc., Kales Building, Detroit, Mich., is consulting engineer.

Duluth, Minn.—Minnesota Power & Light Co., Duluth, plans expansion in local M. L. Hibbard steam-electric generating station, with installation of new 33,000-kw turbine-generator, high-pressure boiler and auxiliary equipment. This will be part of 1950 extension and improvement program of company, estimated to cost approximately $8,000,000.

Winona, Minn.—Mississippi Valley Public Service Co., Winona, will begin superstructure soon for proposed addition to local generating station, 75 x 140 ft, with new 200 ft steel stack. Installation will include a new turbine-generator and auxiliary equipment. Project is scheduled for completion by close of year. Pioneer Service & Engineering Co., 231 South LaSalle St., Chicago, Ill., is consulting engineer.

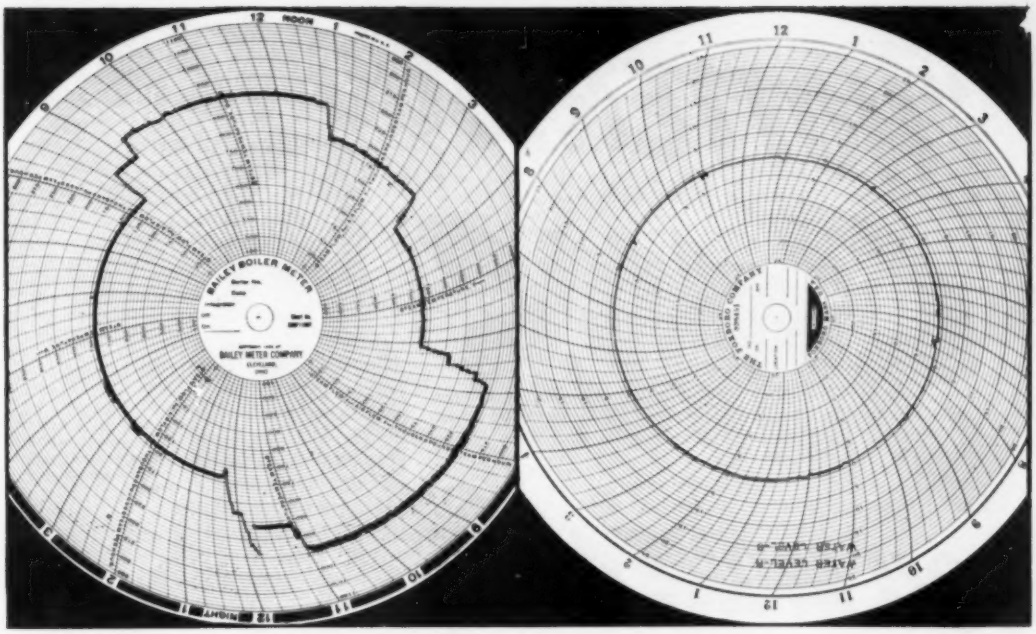
Collins, Miss.—Town Council plans extensions and improvements in municipal power plant and waterworks station, with installation of additional equipment. Cost about $75,000. Bond issue in that amount has been authorized. Work will be carried out soon.

Chillicothe, Mo.—Town Council will make extensions and improvements in municipal steam-electric power plant and waterworks station, with installation of additional equipment for increased capacity. Bond issue of $565,000 has been approved for project. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Savannah, Mo.—North West Missouri Electric Cooperative, Inc., will have plans prepared soon for new steam-electric generating station near Missouri City, Mo., with initial capacity of 40,000-kw. Financing in amount of $18,393,000 has been arranged through REA, to provide for construction, extensions in transmission and distribution lines, and other expansion in facilities.

Toms River, N. J.—Ciba Pharmaceutical Products Co., 556 Morris Ave., Summit, N. J., drug and pharmaceutical products, plans boiler plant at new factory at Toms River, for

(Continued on page 132)



Left: Steam flow from B & W Type FH Boiler rated at 275,000 pounds per hour, 900 psi, 910 F. Right: Drum level held within ±½ inch by COPES Flowmatic

The most important boiler plant in the world is yours

You hear a lot about one plant or another being important. But no other plant in the world is as important to you as the one for which you are responsible. All any other plant means to you is a chance to learn how to better your own.

Take the boiler from which the charts above were obtained. That it is one of the largest Babcock & Wilcox Integral Furnace Boilers ever built concerns you only because operating experience with it can help you with your own operation.

Study the charts carefully. How do your loads compare? Do you have such sudden sharp changes in rating? Is your drum level held as closely despite the changes? It can be — if your boilers, like this one, are equipped with COPES Flowmatic feed water control. And simple routine care by plant personnel takes care of all maintenance.

Write for Performance Report 487 on this public utility plant. It might help you better the world's most important plant — your own.

NORTHERN EQUIPMENT CO.
402 Grove Drive, Erie, Pa.

BRANCH PLANTS: Canada, England, France, Austria, Italy. *Representatives Everywhere*

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.

"HOTTER, SOONER" Saves YOU MONEY

Yarway Impulse Steam Trap with new stainless steel body.

Yarway Impulse Steam Traps get equipment hot and into production *faster*. Extra profits!

Then they keep it *continuously* at peak operating temperatures for maximum production. More extra profits!

What's the reason for *hotter, sooner?* Just this. When steam is turned on, Yarways open wide, discharging the air and condensate *in a hurry* —closing only when steam arrives. Then, when operating temperature has been quickly reached, the little valve (only moving part) literally *floats on the load* . . . discharging heat-retarding condensate as soon as it forms instead of waiting for quantities to accumulate. Thus equipment is held at peak operating efficiency.

Other economical features of Yarway traps—minimum maintenance, easy installation, low initial cost.

More than 600,000 Yarways have already been installed. Sold by distributors throughout the world.

Try a Yarway today . . . standardize on Yarways tomorrow.

YARNALL-WARING COMPANY
114 MERMAID AVENUE, PHILA. 18, PA.

Nest of Yarway traps installed with Yarway Strainers on cloth dryer. Note small space required.

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

FISK OPERATOR LIKED IT

YOU CAN WELL imagine my interest when, receiving my January, 1950, copy of POWER GENERATION, and opening it to the first article, "At the Turn of the Half Century," I began to read the story of how I spent my New Year's Eve this year. Yes, I was the operator you saw in charge at Fisk Station Control Room No. 1 on the night of December 31st-January 1st.

Your accuracy of description is uncanny. Except for some very minor details, your account of our thoughts and actions was perfect.

I thought you would also be interested to know the operator that evening has been a subscriber to POWER GENERATION for the past few years.

Well, thank you for the entertaining article, and for the many other interesting and informative articles I have found in the pages of your magazine, under its present title and its previous title *Power Plant Engineering*. You are doing a swell job of keeping me up with the developments in this fast-moving field.

Chicago, Ill. BERNARD T. DAVIS

BOILER HORSEPOWER

REFERRING to Mr. Engelman's example and solution at the top of page 87, October issue in his article on Basic Power Plant Figuring, he uses a value for boiler horsepower equivalent to the evaporation of 34.5 lb of water per hr from and at 212 F; that is, 34.5 × 970.3 = 33,475 Btu per hr. In comparison, steam at 300 psia and 600 F total temperature as given in the problem has enthalpy of 1314.4 Btu per lb.

Hence, under these conditions, and assuming 210 F feedwater temperature, generation of 33,475 ÷ (1314.4 —178.0) = 29.459 lb per hr of steam amounts to one boiler horsepower, instead of 34.5 lb per hr. This discrepancy has not been taken into account by Mr. Engelman; and I am calling attention to it because it might mislead those readers who are receiving most benefit from this series of articles.

Baton Rouge, La. C. E. ELLSWORTH

Engelman's Reply

MR. ELLSWORTH is entirely correct in his calculations, and has brought out the difficulty of interpreting a rating in terms of boiler horsepower. The figures given by Mr. Ellsworth assume that the heat-saving devices, such as stage heaters, economizer, and superheater surface are included in the boiler surface for rating purposes. This would mean that a factor of evaporation of 1.16933 has been omitted from the published calculation.

However, many engineers do not consider the economizer and superheater as part of the boiler surface. For a rating on this basis, the value of 34.5 lb per hr is not unreasonable. It assumes that water enters the boiler from an economizer at 264 F, or from a stage heater operating at about 38 psia, and that the superheater surface is not included in the boiler rating. Certainly a stage heater would not under any condition be included as boiler surface.

However, the object of the problem was to show the method of finding the proper size of the steam line. For this purpose, the value of 34.5 lb per hr is quite realistic. No doubt the feedwater temperature should have been stated to avoid confusion. It will be recognized that in the absence of more detailed information, the 34.5 lb per boiler horsepower is on the safe side.

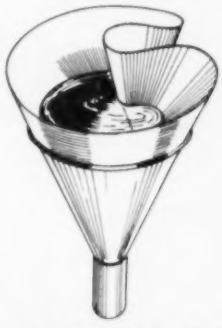
Steam at 300 psia and 600 FTT, H is .....1314.7 Btu per lb
Feedwater at 212 F ..... 180.1 Btu per lb
Heat by heater, economizer, boiler, superheater .....1134.6 Btu per lb
Factor of evaporation = 1134.6 ÷ 970.3 = 1.16933
Also 33,475 ÷ 1134.6 is 29.504 lb of water evaporated per boiler horsepower
Again, 34.5 ÷ 29.504 is 1.16933 or 116.933 per cent

Cleveland, Ohio WILLIAM H. ENGELMAN

FILTER PAPER

IT WAS very fine to see my article* in the January issue, showing how a little trick with the filter paper prevented the capillary action that caused filtrate to come down cloudy when we were filtering boiler water in our various boiler water tests.

Here is a little additional data, in order to keep the record up to date on this subject. The original article was written some months ago and we used the method of folding filter paper and the shorter funnel that eliminated siphonage as described then. However, since we first adopted the new method, we have observed once in a long while that the filtrate still came down cloudy, even though the filter paper projected above the rim of the funnel.



Elevation and plan showing how filter paper can be folded to eliminate all possibility of capillarity between paper folds

We could think of no theory to explain this except that perhaps the folds of the filter paper themselves might be so close that they provided the necessary siphonage path.

Accordingly, after some further study, we decided to arrange the filter paper with the folds as shown in the accompanying sketch. Note that paper does not touch paper at any point. Since using this method, we have had perfect results and we believe that it completely solves the problem.

Atlantic City, N. J. A. THOMPSON

*A Shorter Funnel Solved This Filter Paper Problem, by A. Thompson, POWER GENERATION, January, 1950, Page 80.

THE GROUNDED NEUTRAL IN THE EAST

THE ARTICLE on page 79 of the January 1950 issue paralleled to a degree my own experiences during a stay in the Far East. The details given by Mr. Los about the protective device used in Holland show some similarity in properties.

The scheme referred to is generally known in British use as "Earth Leakage Protection" and has been much written about in the British technical publications by Mr. T. C. Gilbert.

The need for such a device where I was located seemed to a degree an outgrowth due to local conditions among which were:

1. Multiple grounding was not approved by the local authorities. Incidentally, grounding conditions were most unfavorable.

2. The use of 250 volts for lighting and all devices increased danger from shock. Actually I knew of a number of fatalities at voltages less than 220 as measured to ground.

3. The servants were usually barefooted and were not robust physically. In addition, the buildings having stone floors permitting moisture to accumulate, particularly during rainy periods, increased susceptibility to shock. It was even necessary to have rubber mats at electrically operated refrigerators since the servants reacted at once to the slightest leakage.

The particular location was in an area in India where distribution was 3-phase, 4-wire, 50 cycles with

(Continued on page 66)

The Greens Bayou Station of

Most recent addition to Houston's electric power system is the new Greens Bayou Steam-electric generating station with an initial capacity of 132,000 kw, in two units. This station is completely out of doors, the two generators being mounted on an extended pedestal which is entirely uncovered. Circulating water is cooled by means of a cooling tower 600 feet long. With a heat rate of about 12,000 Btu per net kwh, the total cost of this installation including step-up facilities and switching station is $88 per kw

By LOUIS ELLIOTT
Consulting Mechanical Engineer, Ebasco Services Incorporated

HOUSTON stands very high, among American cities, in rapidity of population growth and of increase in electric load. The region is endowed with great natural resources, and the enterprise of the citizens of Houston has been such as to take advantage of these resources. From 1920 to 1948, Houston population increased at the rate of nearly 5 per cent annually, compounded, as compared with a country-wide percentage of a little over 1 per cent.

Power load has grown since the early 1920's—about which time the author of this story became acquainted with Houston's power problems—from around 20,000 kw up to well over 400,000 kw, with the expectation that it will rise to 800 or 900 megawatts by 1960. The load growth from 1920 on is at the rate of over 10 per cent annually, compounded, in comparison with the corresponding rate of growth for the United States of about 5 per cent.

The most recent addition to power capability is that of the Greens Bayou station, located approximately 9 miles northeasterly from the center of Houston and feeding into the transmission ring around that city. It contains two 60/66-mw 850-psig 900-F Preferred Standard turbines, each one served by a single gas-fired steam generator. Cooling towers are used for circulating water, with make-up from wells. Boilers are outdoor-type, with a canopy over firing aisle; turbine-generators are installed outdoors, on a concrete pedestal which also carries a gantry crane. Housing provided includes a control room, and a separate building for offices, shop and stores.

The plant will provide at least 135 mw net output in the peak-load season during summer and fall. Total cost per kilowatt of the 132,000 kw rated capability of the two turbines is $80; as above stated, the two units give more than 132 mw net output. The unit cost quoted covers land and all overhead and general expenses, but not the step-

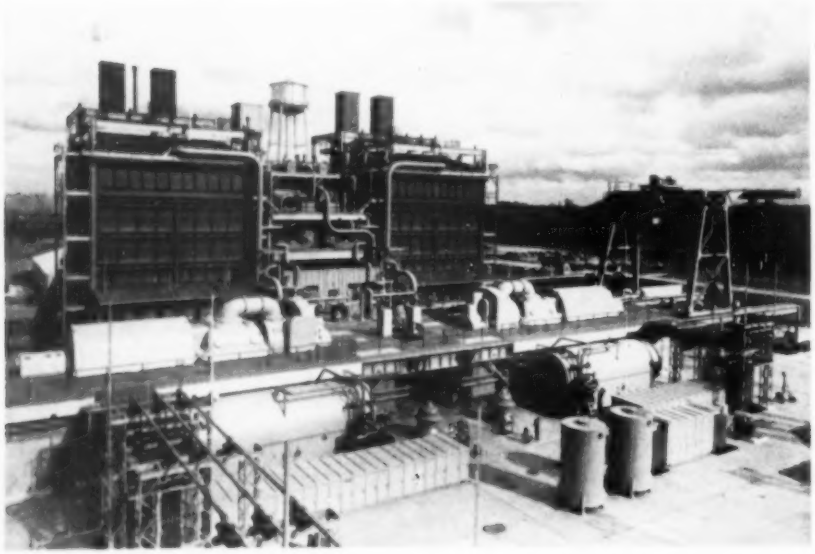


Fig. 1. Station from the turbine side, showing the two 60/66-mw turbine-generators on an open deck, with gantry crane overhead. This view also shows one of the two condensers serving each turbine and the two steam generators in the background

Houston Lighting and Power Co.

up facilities and switching station and a small distribution substation; these add approximately $8 per kw (on the 132,000 basis). It is gratifying that by careful design, utilizing the new outdoor type of plant, unit investment has been brought down to the low figure quoted. The saving as compared with the conventional fully housed station is probably between $10 and $15 per kw or at least $1,500,000 for the first two-unit development.

Historical Development of System

The Houston area, enclosed within a transmission ring, is a square approximately 12 miles on a side. The general region, served by Houston Lighting & Power Co., extends 25 to 50 miles from the city and includes Galveston on the Gulf of Mexico.

The management of the company has been farsighted and enterprising, in providing an efficient power system to supply the rapidly growing demands of its customers. Gable Street station, dating back to about the beginning of the century, with a capacity in 1920 of about 21,000 kw, was the source of power supply for Houston. The first major addition to power facilities was the Deepwater plant, a few miles east of Houston on the Ship Channel, which was used for condensing purposes. The initial installation, 1923-1924, included two 20-mw turbine-generators, followed in 1927 by a 25-mw unit, and from 1929 to the early 1930's by two 35-mw units together with a 12,500-kw superposed unit. This topping turbine employed what were then advanced steam conditions —about 1300 psig pressure and 850 F steam temperature at superheater outlet or at inlet of steam reheater; the installation was one of the earliest reheat jobs. The station utilized oil as fuel during the early period. At that time coal was looked forward to as a possible future fuel but later gas became the main steam fuel, with oil as standby.

The Houston management early adopted the broad viewpoint that the most economical, reliable and otherwise best method of serving the territory would be by means of a number of steam plants strategically placed around the city, with a transmission ring around Houston constructed progressively with installation of new stations and growth of load.

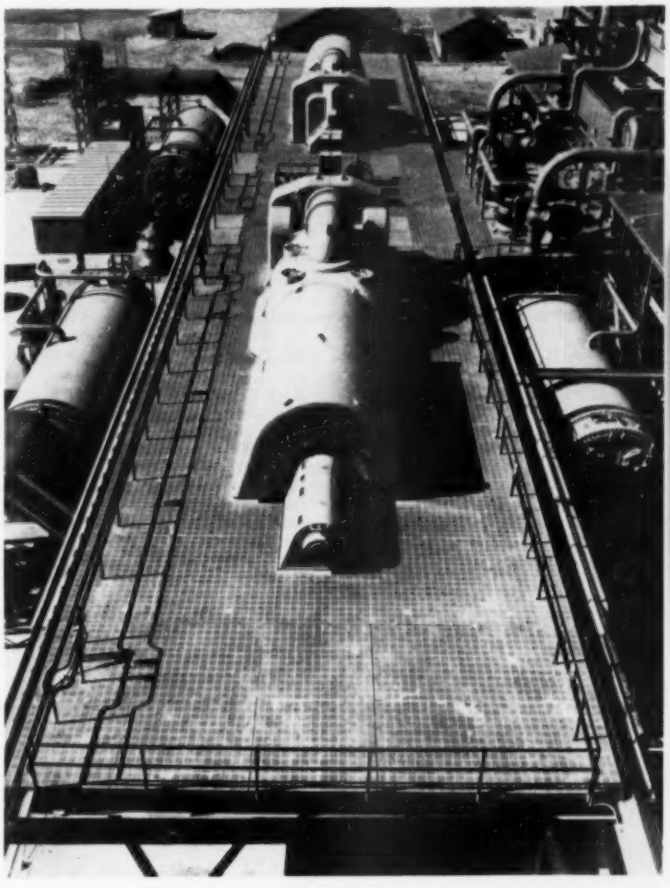


Fig. 2. Turbine deck, longitudinal view showing the two turbine-generators, the condensers, and the gantry crane rails

Following this policy, a station called West Junction was next authorized, being located to the southwest, on the transmission ring, about 10 miles from center of city. The site was selected for its convenient access to natural-gas supply —which has been for a long period and is now the base fuel supply for the Houston district, as well as for its location with respect to general system development. With West Junction in the southwest, Deepwater in the east and Gable Street in the heart of the city, the area was well covered.

The first unit of West Junction, installed in 1943, was rated 37,500 kw maximum, but gave a net output greater than that. It was designed for 850 psig 900 F steam conditions, and utilized cooling towers for the condensing water, with make-up from wells. A second similar unit was added in 1947, and a third and fourth are authorized, for operation in 1950 and 1951; these are 60/75-mw's, utilizing the same steam

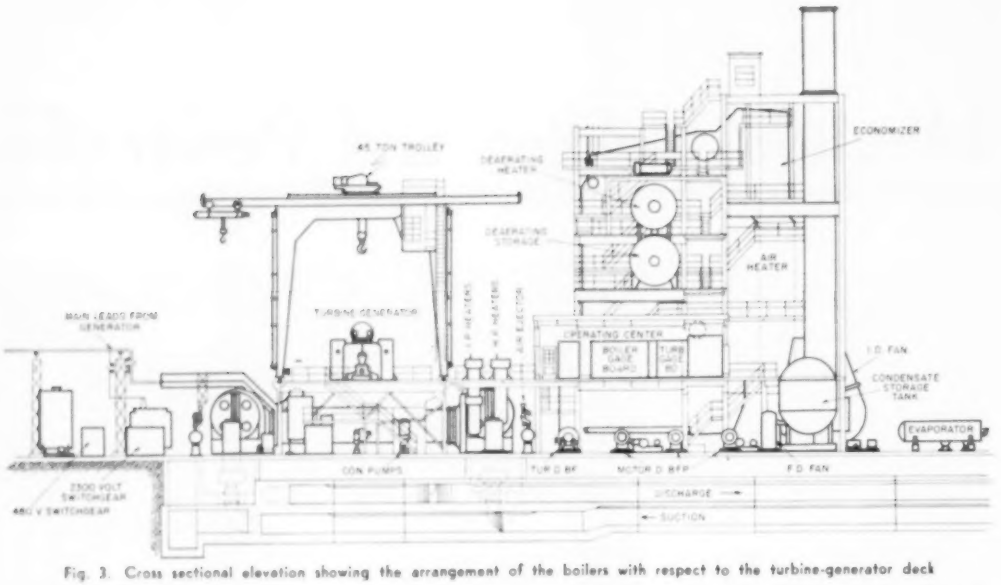


Fig. 3. Cross sectional elevation showing the arrangement of the boilers with respect to the turbine-generator deck

conditions as Units 1 and 2. This station will then have an actual net generating capability of over 225 mw. The original West Junction was one of the pioneer semi-outdoor plants, with outdoor boilers, and turbines placed in a light removable housing served by an overhead gantry. Unit 3 and Unit 4 turbine-generators will be placed outdoors, the turbines having dual side exhaust, bringing turbine-generator base down to within 12 ft of the ground slab.

The old Gable Street station, located not far from the business center of Houston, has been modernized. A 25-mw 850-psig 900-F turbine and semi-outdoor steam generator were installed in 1939, and a 30/33-mw Preferred Standard unit will be put into operation during first half of 1950. At Gable Street there is a large distrbuting substation, and the location is an excellent one for a plant of 90-mw—which will be the approximate capability in 1950.

In addition to power from Gable Street, Deepwater, West Junction, and now Greens Bayou, which are chief sources of supply for the Houston load, there has been some purchase of power over a number of years. In addition, a supply has been obtained from an installation in a manufacturing plant from a war plant that during the war produced materials for manufacture of synthetic rubber.

Three small turbines, aggregating something over 20,000 kw and operating chiefly against back pressure, were installed by Houston Lighting & Power at an industrial plant about a mile from the Deepwater station; part of the steam supply is piped from Deepwater and the remainder from boilers adjacent. The agreement between Houston Lighting & Power and the industrial company provides for benefits to both parties from this cooperative project. From the other installation mentioned, which is leased by the power company, about 40 mw is obtained from a back-pressure turbine exhausting largely to atmosphere through Maxim silencers. This power, utilized at relatively low load factor, has constituted a useful supplement to the base supply, especially during recent years when it has been difficult to keep up with the load

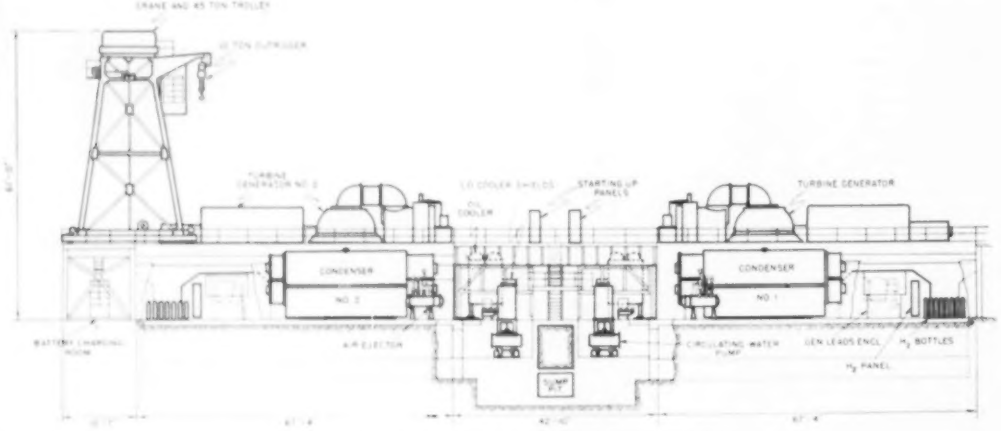


Fig. 4. Longitudinal elevation of the turbine-generator deck

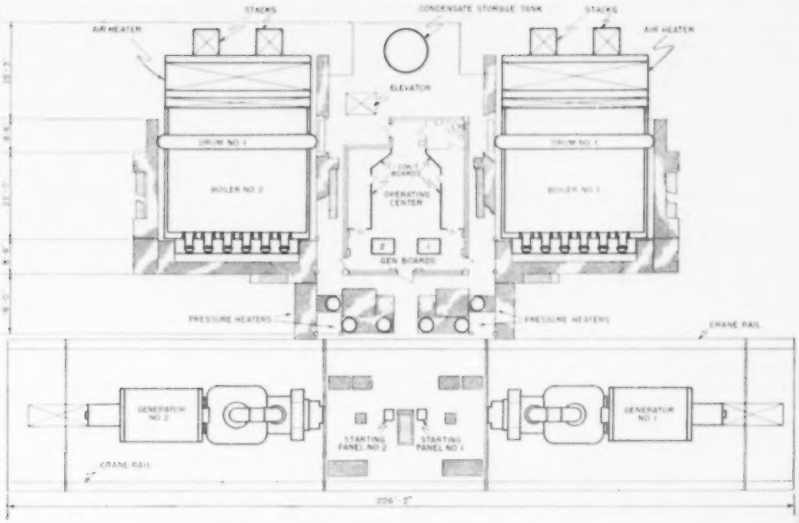


Fig. 5. Plan of the station showing the control room between the two steam-generators

growth with new plant installations.

The most recent step in system development is the Greens Bayou station, mentioned above; this connects, at the northeast, to transmission ring around city. While both Deepwater and Greens Bayou will be along the easterly side of this ring, there is a heavy industrial load still farther to the east.

Total net capability of the Houston system, not taking to account the availability of purchased power, will be approximately 600 mw after the installation of the two 75-mw units at West Junction. Studies are under way for future developments, which will include extensions to existing plants, and the construction of a new station northwest of Houston. It will not be long before units of the magnitude of 100 mw will be utilized, doubtless with steam conditions higher than those now used—which were economic for fuel costs prevailing.

Water Supply

One of the main problems in developing a power system and other large industries around Houston—as with other important centers of population and electric load in the United States—is that of water supply. While the Ship Channel provides condensing-water facilities for Deepwater and water supply for other large industries, there is no steady flow through the channel in Houston and for some distance east. Farther down the channel, it receives inflow from San Jacinto River. A recent article in *Chemical and Engineering News*, entitled Industrial Water on the Gulf Coast, stated that flow into the Gulf, in all rivers within 100 miles of Houston, is from 1500 cfs to 37,000 cfs—the latter during flood conditions. It was further stated that current water use in a 17,000-sq mi area between the Rio Grande and the Sabine Rivers is equivalent to from 4000 to 7000 cfs.

Houston is therefore in an area in which considerable expense is usually incurred in providing water supply. All H L & P power installations after the Deepwater have found it economical—indeed necessary—to depend upon water supply from wells, serving as make-up for cooling towers. The location value of

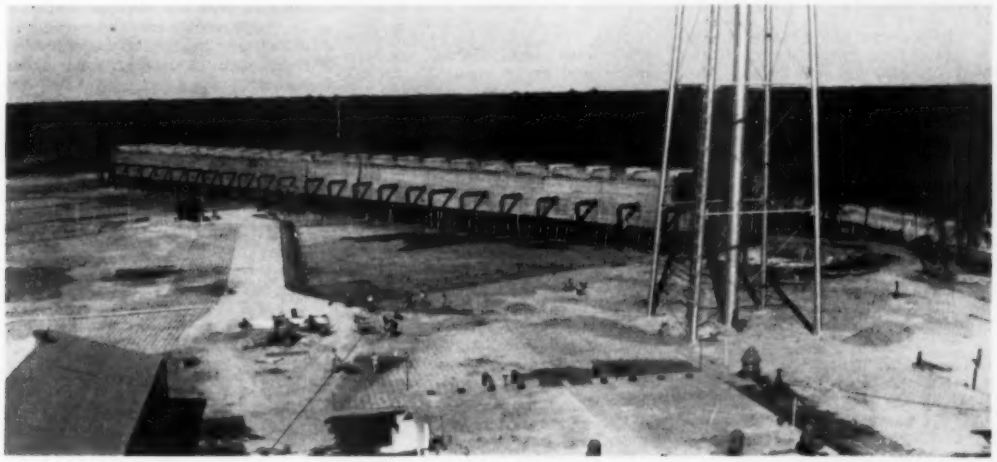


Fig. 6. The 600-ft long cooling tower serving the two turbines with settling basin and makeup water from wells in the foreground. Base of the water tower at the right

the plant far outweighs any additional expense necessitated by this method of cooling condensing water. The Greens Bayou plant, when developed—as expected—up to perhaps 500 mw, may require an average make-up of 20 or 25 cfs, and it is anticipated that this can be obtained from wells scattered over a considerable area.

General Design of Greens Bayou Station

A large tract of land was acquired for the plant. The cleared and graded area, is roughly 1500 by 3000 ft. A large site is required for a station of this type, to afford adequate space and clearance for cooling towers, location for water wells—which should be spread over a large area, and space required for switch and transformer yard and for transmission lines.

Figure 1 gives a general view of the plant from the turbine side, showing turbine-generators mounted on an extended pedestal, which also supports the gantry-crane rails. In the foreground are step-up transformers, connecting the plant to the Houston transmission system. Figure 2 shows the appearance of turbine-generator pedestal with the four condensers on the level below. Neither of these pictures gives a plain indication of the control room, which is located between turbines and boilers and on the center line between the two units. It is anticipated that, for Units 3 and 4 a new control center will be provided; there will be, in large measure, a separate operating force for the second pair of units.

As in many other semi-outdoor designs with simplified structures, station equipment is placed on a slab with floor at approximately ground level. Expense for excavation and substructures are therefore largely eliminated. The combined turbine pedestal and gantry-crane runway is 16 ft above base slab, this relatively low head-room being made possible by use of twin condensers connected to the turbine exhaust by a T-piece. Each turbine unit is served by two 30,000-sq ft condensers and two 67-cfs circulators. Circulating pumps are vertical-type, located outdoors, taking their suction from a tunnel leading to the cooling-tower basin, pumping through the condensers and discharging through a tunnel to top of cooling tower.

The tower is about 600 ft long and 50 ft wide, served by 48 induced-draft fans; it is rated at a cooling duty of 1,000,000,000 Btu per hour.

Boiler Equipment

The steam generators each have a rated capability of 675,000 lb per hour at 920 psig 905 F, superheater by-pass dampers being designed to give constant steam temperature down to about two-thirds of maximum load. Each unit has two forced-draft and two induced-draft fans mounted at grade, there being two rectangular stacks carried up along the rear of each boiler. Unit is designed for natural gas as base fuel, with oil used as standby.

Turbine Equipment

The turbine-generators are Preferred Standard, the standardized rating specifying a turbine capability of 66,000 kw, a generator rating at 0.5-psig hydrogen of 70,588 kva at 0.85 pf, and a capability at 0.85 pf, with 15-psig hydrogen, of 81,176 kva. Actual gross generating capability of this size unit in the Preferred Standard line has been shown as higher than rated turbine capability, with normal steam conditions and 2.5-in. back pressure, by at least 5 and sometimes 10 per cent.

As above stated, turbine-generators are outdoors, with no protection from the weather except that proper sealing is provided to prevent entrance of moisture into the machines.

The heat-balance layout involves a conventional regenerative cycle, with four heaters. The estimated economy of this station is about 12,200 Btu per net kwh for a figured load of 137 mw net output. This represents normal performance for a station with steam conditions 850 psig 900 F, with 4-point bleed, and with a steam-generator efficiency of 84 per cent when using natural-gas fuel.

Deaeration is provided by a single deaerating heater serving both units.

Control System

The central control room contains all electrical and mechanical control apparatus, duplicate instruments as required being placed near boilers and turbines. The operating center also contains controls for synchronizing the generators with the system, through the step-up transformers. However, in view of the number of outgoing and incoming power lines, a separate control house in the switchyard is provided for these lines. Some controls are automatic and some manually remote-operated. Complete combustion control is provided.

With four operators per shift, for the two-unit station, there will be a total operating force of 21 or 22 men, including provision for superintendence. Maintenance labor is drawn in large part from a "maintenance pool" serving all the Houston plants.

Electrical Equipment

Generator leads, constructed of copper pipe, run overhead to main power transformers, protected by a wire enclosure. Disconnects only are provided between generator and transformers. Main auxiliary transformers are placed near generator pedestal, connected solidly to generator leads. All auxiliary as well as main transformers, and all auxiliary circuit breakers are outdoor-type. One 3-phase self-cooled transformer per turbine-generator, with provision for future fan cooling, steps up from 12 to 66 kv; transformer rating is 75,000 kva self-cooled, 93,750 kva with forced-air cooling.

Ebasco Services Incorporated was employed for design and construction on the Greens Bayou station. Members of Houston Lighting & Power Company cooperated fully throughout the design period, and the cooperation was found very effective in working out the best design. This was particularly true because Greens Bayou incorporates many new features, and indeed constitutes a new character of outdoor-type station.

SIMPLER CONTROL FOR WIDE-SPEED-RANGE MOTOR

ADJUSTABLE speed of wide range is the order of the day for industrial drives. One means of fulfilling this requirement is the wide-speed-range d-c motor, which gives an adjustment as high as eight to one by field control alone. The method of regulating this motor has recently been simplified.

With the original scheme, both field windings were adjusted in strength (one field being reversed), which necessitated two rheostats. In the new system, only one winding is varied, using a single potentiometer-type rheostat, which simplifies the control equipment of the motor.

The speed range of a standard shunt motor is generally limited to four to one, a limitation imposed by the effects of residual magnetism, distortion and demagnetization of the main field by the armature, and increased reactance voltage. These factors contribute to instability and poor commutation when the field of the motor is weakened beyond about one-fourth maximum.

However, the speed range can be extended by minimizing these limitations. This has been accomplished in the wide-speed-range motor by using two independent field windings, each having an independent coil on each of the four poles. One of the field windings is connected in the standard manner, producing alternate polarity poles. The second winding is connected with the coils on the upper pair of poles cumulative to the first winding, and the coils on the lower pair of poles differential to the coils of the first field winding.

The eight-to-one motor is adaptable to almost any equipment requiring a wide speed range. Because this motor, like all shunt motors, has a constant-horsepower characteristic, it is particularly suitable where high torque is required at low speed. Because a two-circuit armature is used, the motor can be built only in ratings of relatively low horsepower. Westinghouse Engineer.

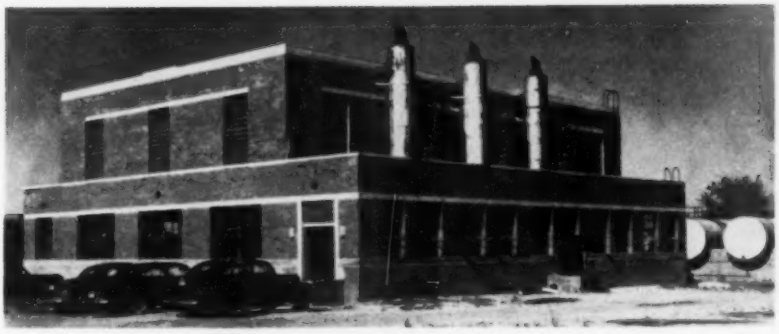


Fig. 1. Diesel power plant of the Missouri State Penitentiary showing exhaust snubbers and intake air filters mounted on a bay on one side of the plant

New Diesel Plant Saves $10,000 in First 4 Months' Operation

New Diesel plant at the Missouri State Penitentiary at Jefferson City, Mo. with three 1440-hp dual-fuel Diesel engines shows excellent economy in the first four months of operation. This plant replaces a steam-turbine plant which was in use since 1938

THREE 1440 HORSEPOWER Superior dual-fuel engines, constituting the largest prison diesel plant in the nation, have started serving a life sentence at the Missouri State Penitentiary. Put into service in May, 1949, the 4320-hp power plant saved the state $10,000 in its first four months of operation. Projects now under way will increase the rate of saving substantially and pay off the entire plant in less than two years.

The penitentiary, located at Jefferson City, Mo., is in truth a sizeable city in itself—in population, industry, and power consumption. Second largest penitentiary in the United States, it has 2900 inmates, the largest prison population within a single set of walls. Within these walls are factories producing shoes, binder twine, commercial cordage, furniture, and many textile products. Here are manufactured all the license plates and highway markers used in the state. Then, of course, there are the laundries, kitchens and other service industries, and a heavy lighting load. This adds up to peak loads of 1350 kw with valley loads never less than 700 kw.

Since 1938, these power requirements have been met by two 1500-kw steam turbines. In theory this should have been an economical arrangement since large quantities of steam were needed for heating purposes. Yet, the dual-purpose plant proved expensive and became progressively more costly as the boilers deteriorated. An engineering study determined that diesels would save the state money even without utilization of waste heat and it was decided to build a modern power plant just outside the walls.

An attractive brick building, trimmed with stone and glass brick, houses the plant. Interior walls are lined with tile, ceilings with an acoustical material. The prime movers are three identical 8-cylinder, 14½ by 20 in., supercharged, dual-fuel Superior diesels developing their rated 1440 hp at 360 rpm. Each drives directly a 1000-kw Electric Machinery synchronous generator with V-belted 15-kw exciter. Auxiliary equipment is in keeping with the quality of the heavy-duty engines.

At the time of this writing, Jefferson City did not have enough natural gas to permit operation of the diesels on gas. But pipe-line expansion will bring the necessary volume within a few months and it was thought advisable to prepare for the important economies of dual-fuel power production. The engines, therefore, are fully equipped and are connected to the gas line so that the engines can be switched from oil to gas merely by pushing buttons on each engine.

Even with relatively expensive oil as fuel, the new plant quickly proved the wisdom of its designers. In June, the first full month of

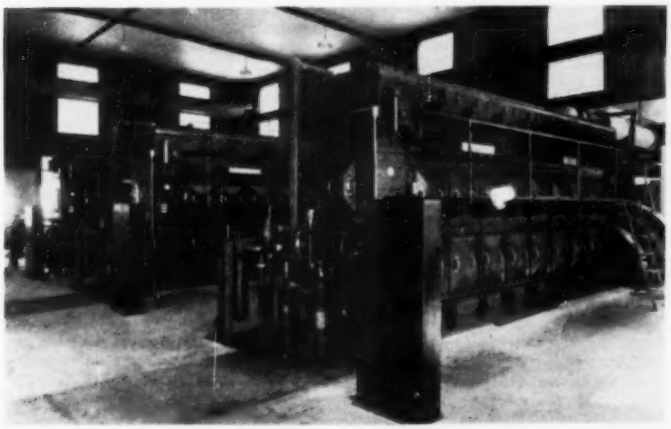


Fig. 2. A view in the engine room showing the three 8-cylinder, 14½ by 20 in. supercharged, dual-fuel Diesel engines

Fig. 3. (Right) Here are shown the gas surge tanks, heat exchangers and oil coolers, a set for each of the three diesel engines

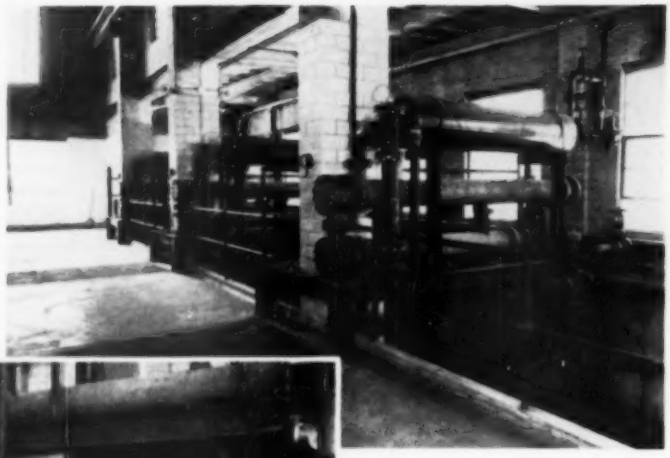


Fig. 4. (Below) In front of the rectangular day fuel oil tank are the cellulose fuel oil filter and fuel meter (left) and lubricating oil pump (right)

operation, the saving on fuel alone amounted to $2639.65. In the first four months, the fuel saving totaled $9598.48. Actually, this saving is figured conservatively. Since the old steam plant provided heat as well as power and since the old boilers are still in use to supply heat, prison engineers calculate the saving by comparing the total cost of fuel for power and heat provided by the steam plant with the combined cost of Diesel power and steam heat under the current arrangement. Thus, the inefficient boilers still are eating into the power savings. New oil-fired boilers, designed specifically for the heating job are being installed and the cost picture will soon be brighter still.

Natural gas will just about double the savings on power. According to the penitentiary's chief engineer, L. W. Fitzpatrick, the present fuel cost per kilowatt-hour is 7.33 mills. With gas at 28 cents per mcf, the cost of fuel for a kilowatt-hour is estimated at 2.86 mills.

As usual, the base of the plants economy is engine efficiency. Table I shows the electric power generated in the first four full months and the fuel and lubricating oil consumed. After a month of break-in and adjustment, the plant settled down to efficient power production. Kilowatt-hour production per gallon of fuel consumed varied between 13.52 and 13.70, depending on the load factor.

Chief Diesel Engineer Arthur L. Johnson sees the reason for these excellent results in careful operation of good prime movers protected adequately by good auxiliary equipment. Fuel, lubrication oil and air are filtered; water is softened. Many aids to efficient operating are included.

The No. 3 Diesel fuel is trucked to the plant and unloaded into three 21,300-gal horizontal steel cylinders resting on concrete cradles above ground. A 700-ft line permits fuel delivery by tank car if desired. From storage the fuel is pumped through meters to three 750-gal day tanks in the engine room. The transfer pumps are controlled automatically by floats in the day tanks. Between day tank and engine, the fuel passes through a cellulose cartridge-type filter and finally a duplex bag-type filter. The day tanks are equipped with a high and low-level alarm designed by the prison's own engineers. Automatic shut-off valves cut off the flow of fuel from storage if the line breaks. As previously noted, gas regulators, surge tanks and all necessary engine equipment are ready whenever Mr. Johnson pushes the dual-fuel button.

Engines are lubricated by a detergent oil which is circulated by the engines' built-in pumps from external sump tanks. Motor-driven rotary pumps also are provided to bring up oil pressure before starting the engines and to keep pressure up when shutting down. Lubricating oil is drawn continuously from each sump tank by a small motor-driven pump and put through a cellulose cartridge filter. There is also a small filter on each engine. Each Diesel is equipped with a shell-and-tube oil cooler.

There is a separate closed cooling system for each engine, with a motor-driven centrifugal pump circulating soft water through a shell-and-tube heat exchanger and the engine jackets. Prison water with 18 gr of hardness is treated in a softener before entering the system. Another set of three centrifugals sends raw water from the exchangers to a duel, induced draft cooling tower which is large enough to handle four engines when required. Even the "raw" water is treated with chemicals.

Engine air is drawn through oil impingement-type filters mounted on the roof of a bay that holds offices and electrical equipment. On the same roof are the vertical exhaust snubbers. The exhaust gases

Table I.—Four Months of Diesel Operation

1949	Kw. Hr. Generated	Fuel Gal.	Kw. Hr. per Gal. Fuel
June	374,400	29,713	12.60
July	491,200	35,914	13.67
Aug.	414,400	30,248	13.70
Sept.	420,800	31,111	13.52
Totals	1,700,800	126,986	13.39

PRINCIPAL EQUIPMENT IN THE
MISSOURI STATE PENITENTIARY POWER PLANT

Engines:	Three 1440-hp, 8-cylinder, 14½ by 20 in., supercharged, dual-fuel Superior diesels operated at 360 rpm. Superior Engine Division, The National Supply Co.
Generators:	1000-kw synchronous generator V-belted to 15-kw exciter. Electric Machinery Co.
Turbo-chargers:	Elliott-Buchi Co.
Fuel transfer pumps:	Roper, George D., Corp.
Fuel meters:	Pittsburgh Equipment Co.
Fuel filters:	Hilco Hyflow cellulose filters. Hilliard Corp.
Fuel filters:	Purolator Products Inc.
Lubricating oil:	North Star 6-X. Cities Service Co. Nonpariel HD. Standard Oil of Indiana.
Lubricating oil pumps:	Roper, George D., Corp.
Lubricating oil filters:	Hilco Hyflow cellulose filters. Hilliard Corp.
Lubricating oil filters:	Purolator Products Inc.
Cooling tower:	Water Cooling Equipment Co.
Water softener:	General Filter Co.
Heat exchangers:	Graham Manufacturing Co.
Cooling water pumps:	Ingersoll-Rand Co.
Air compressors:	Quincy Compressor Co.
Air filters:	Air-Maze Corp.
Exhaust snubbers:	Burgess-Manning Co.
Silencer on turbo-chargers:	Air-Maze Corp.
Pyrometers:	Alnor, Illinois Testing Laboratories, Inc.
Voltage regulators:	Allis-Chalmers Co.
Meters:	Westinghouse Electric & Mfg. Co., Inc.
Circuit breakers:	Roller-Smith
Watt-Hour meters:	Duncan
Rectifiers:	Westinghouse Electric & Mfg. Co., Inc.
Switchboard:	Wm. Wurdack Electric Co.

in these super-charged diesels turn turbines which force air to the power cylinders under pressure with resultant increase in engine capacity.

Starting air is provided by two small compressors, one motor-driven, the other powered by a gasoline engine. The motor-driven unit is controlled by an automatic switch which keeps 210 to 250 psi pressure in the three air tanks.

A compact control panel near each engine includes an exhaust pyrometer, pressure gages, auxiliary control switches, and an alarm system with horn and signal lights.

The modern dead-front switchboard, set flush with the wall, is particularly well equipped. Each engine panel has an a-c and d-c ammeter, a power factor meter and synchronizer switch. The synchronizer panel includes a 120-v voltmeter which, the operators feel, permits a closer check on voltage than the usual high-voltage meters. With the rocking-contact regulators, the plant has been able to keep within one volt of the desired voltage.

Conveniently grouped controls at the engine and on the switchboard make it possible for one operator to start an engine and put it on the line under heavy load in about a minute, according to Robert S. Nash, Senior Power Engineer of the prison engineering department, who has played an important part in the design, construction and operation of the plant.

Electricity at 2400 v is distributed through simplex anhydrex underground cable to five prison substations where it is transformed to 480 volt 3-phase current for power use and 120/240-v single-phase for lighting.

Plans for landscaping the exterior and painting the interior will make this plant even more a show-place than it is today. All piping will be color-coded with white for raw water, gray for jacket water, brown for fuel oil, orange for lubricating oil, yellow for starting air, and red for gas. The walls above the tile will be cascade green, the engines, generators and accessory equipment a medium green, the floors gray.

But in the prison offices and over in the Capitol, the prettiest sight of all will be the power plant balance sheet. Even before the advent of gas, Col. Ben Marvin Casteel, director of the Missouri Department of Corrections, state prison body, is enthusiastic over the dollars and cents power savings of the diesel generating plant as compared to the old steam generation facilities.

LETTERS

TO THE EDITORS

(Continued from page 53)

250 volts line-to-neutral, giving a nominal value of 433 volts line-to-line. The neutral of the transformer bank, usually a three phase unit, was grounded at the bank only; all service connections were 2-wire, single phase, line-to-neutral at 250 volts. Some 3-phase installations were arranged with complete protective equipment.

The circuits consisted of two insulated and one bare conductor under a lead sheath and in later installations a non-metallic material. The bare conductor was connected to any exposed metal of each fixture or appliance while at the supply point it was connected to one terminal of the trip coil of the "earth leakage trip," the other terminal of the trip coil being connected to ground usually by means of a driven pipe or rod. The local authority did not permit grounding of the neutral service connection at the entrance point.

The purpose of the device was to disconnect the supply at once if any ground developed at any device or point of circuit.

The so-called trip, so far as this writer was able to learn, was developed in Europe before 1935 but was later available from a number of manufacturers in Great Britain. Actually the units were very compact measuring approximately four by six inches and four inches high. Shop tests indicated positive and consistent operation at 22 volts, plus or minus 2 volts, to ground with a circuit impedance of 200 ohms and at 65 volts minus, with 800 ohms impedance. The cost delivered was low, less than $5 per unit.

The actual applications were mostly to installations having one or two circuits but where many circuits are involved, continuity of service would require a device for each circuit or for groups of circuits.

The first application was at a dairy farm where the milking machine voltage was 25 volts. It was found, to obtain positive action, necessary to connect the "trip" wire to the "high side" circuit conductor.

Tests indicated operation at currents of less than 0.02 amp through the release coils. The unit was positively "trip free" and could not be closed with a fault on the circuit. A button at each unit made possible periodic tests. This button was sealed.

It was of interest to learn of the commercial availability of such a senstive protective device at such a relatively low cost. Whether it can or should be applied to installations in the United States seems a question of experience and operating policy. It may be with the lower voltages in use in the U.S.A. for domestic service and small appliances and recommendations for service to portables in boiler interiors or kindred work to 32 volts, the application of such a device may be of limited necessity.

Brooklyn, N. Y. C. O. VON DANNENBERG

Central Control Rooms—Design & Operation

By B. F. BORGEL,
Pennsylvania Electric Company

CENTRAL CONTROL ROOM of the Warren, Pennsylvania station of the Pennsylvania Electric Co. is basically a balanced combination of control and supervisory rooms, and is a result of that company's extensive investigation into the field of centralized control, as well as an indication of a firm belief in the advantages and economics of this type of plant control. This particular installation is serving as a proving ground for various changes which will be incorporated in future plant design, and will therefore be used to illustrate the engineering policy being followed by the Pennsylvania Electric Company in this and future plants, and to bring forth the experiences encountered in the operation of this room. Though the soundness of the design has been amply proved in operation, experience has indicated several desirable basic changes, which will be incorporated in future installations.

System Operating Problems Affecting Centralization

This company's system, which is spread over a mountainous area 300 miles in extent, is subjected to severe disturbances from electrical storms, which frequently isolate a generating station from the system, causing the loss of all load except that in the immediate area. During these conditions, the plant facilities must be maintained in such a manner as will permit immediate load pickup when tie lines are reclosed.

Aggravating this situation is the fact that several of the stations are located in metropolitan areas, and in other sections are located oil refineries, rayon mills, electric furnaces, etc. To take advantage of the low generating costs represented by the company's mine-mouth plants, power is frequently transmitted as much as 200 miles into the metropolitan areas. During these periods, the area plant must be able to pick up load from minimum to maximum in the event of any tie line disturbance, and to accomplish this without any objectionable drop in voltage or frequency.

Attempts have been made in the past to effect faster internal plant communication by various means: first, by telephone stations at key operating positions; this led to the use of common loud speaker systems; third, location on boiler control boards of the governor control of the turbine served by that boiler, thus turning over to the boiler operator the control of turbine load. These moves definitely speeded operation during emergencies, and indicated more efficient operation during normal periods, but underlined the necessity for one key operator to be constantly cognizant of the condition of all equipment in the plant so that he may properly coordinate the actions of the other operators.

How Control Room Was Designed

To meet this demand, the central control room system was investigated and adapted to the particular needs of this company, as presented in this paper by the author before the 1950 Annual Winter Meeting of AIEE. It was not felt that a control room in which was concentrated all control of all equipment in the plant was feasible, since experience had indicated that sufficient operators must be used to permit satisfactory operation of the plant manually upon loss of one or more controls. It was felt that it would be advantageous to concentrate, in a central control room, sufficient indicating and alarm systems to furnish the operator a full picture of plant operation at all times, as well as full control of all equipment required during emergency operation. With this end in mind, the room was designed to incorporate the necessary equipment for:

a. Operation of boilers, generators, and station auxiliary power supply.

b. Indicating and recording supervision of turbines, hydrogen systems, and feedwater systems.

c. Annunciator alarms on miscellaneous plant equipment such as water screens, service pumps, storage tank levels, air compressors, etc.

Details of Panel Design

Experience had indicated the desirability of control boards arranged for maximum ease of operation, and particular attention was paid to this phase of the design, as in Fig. 2.

For example, sequence of operation of each boiler panel is from left to right, starting with induced-draft equipment, followed by forced-draft equipment, and two sets of pulverizers. Vertical segregation of all equipment has been followed. Thus, the remote control station and position indicators for the induced-draft inlet-vane drive unit are directly below the induced-draft-fan motor control stations and ammeters. All start-stop stations are in a horizontal line at one level, and all remote control stations are in a horizontal line at another level on the panel board.

On the station power boards, the switch controls are arranged horizontally by voltages and vertically by sequence of operation. Pistol grip denotes breaker control, oval is used on remote operating controls, round smooth on governor and field controls, round knurled on current and potential transfer switches. Instruments and draft gages indicating the changes resulting from control operation are located vertically above the corresponding control stations on the panel boards.

Design Was Justified by Results

The Warren plant was placed in service on August 15, 1948, and operation since that time has amply justified the faith of the engineers in the advantages of a central control room. The plant was manned with experienced operators in the central control room, and new operators with no previous power plant experience in all other operating posts.

No misoperation by the new operators, who work directly under orders of the control operator, has resulted to date. During the start-up period we had a total of 17 trip-outs of the machines at full load due to staged relay testing and accidental trip-outs. In all cases, the machine

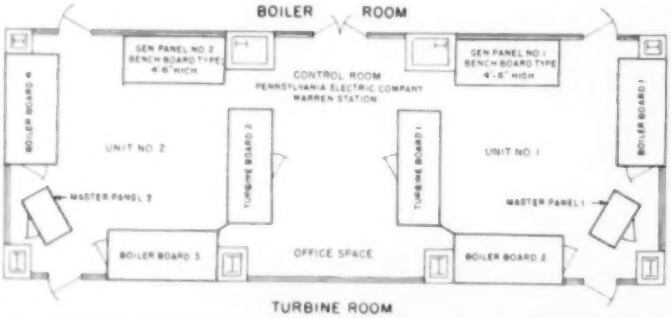


Fig. 1. General plan of central control room, Warren Station, Pennsylvania Electric Co.

Other discussion of centralized control rooms was given in Centralized Control of Steam Electric Power Stations, by R. C. Mallory, POWER GENERATION, March 1950.

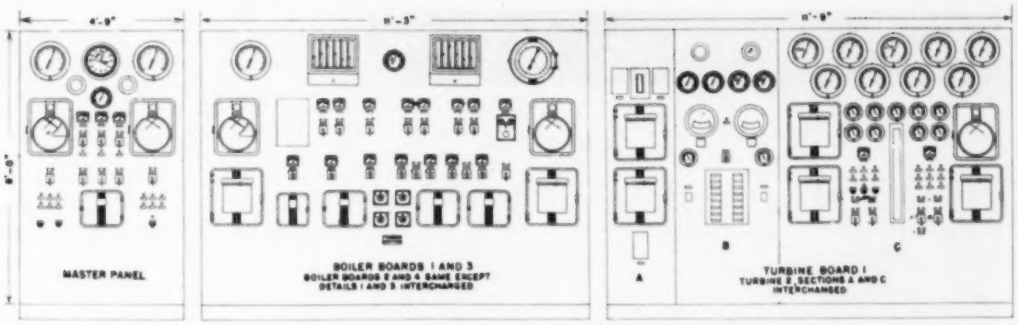


Fig. 2. Instrument arrangement on various control boards in Warren Station's control room

was resynchronized and the plant returned to full load in less than 5 min elapsed time. The best record for this performance was 1 min, 30 sec, in which case the operator did not trip out any mills, but being able to see at a glance the condition of the plant, resynchronized the generator and put on load, allowing his safety valves to open and dump the excess steam for the required period.

This operating condition was duplicated in another plant of this system which is identical in design with Warren, lacking only the central control room, and a minimum of 11 min was required from trip-out of the generator to re-establishment of full load on the unit.

Desirable Design Changes for Future

It was recognized that actual operation would indicate desirable basic changes in design which could be incorporated in future planning. These changes are as follows:

1. Concentration on the board fronts of only those indicating instruments which are required for minute to minute operation. Board fronts in a central control room are by far the most expensive surface per square foot in the station, and such valuable space should be utilized only for instruments and controls vital to station operation. Recorders, which primarily register trends and provide permanent records, should be located on the backs of the control cubicles, or in a location adjacent to the control room which would be readily accessible to the operator for periodic checking. A common monitoring system covering all points of temperature on the equipment will be used, permitting constant checking by the operator.

Investigations are now being made of small indicating instruments in parallel with recorders such as steam flow-air, flow, water level, etc., on the board fronts, as well as the development of smaller meters for pressures, drafts, etc. Unless the board fronts in a control room are kept to such a length as will permit normal coverage by one operator, the major benefit resulting from central control design will be lost. Application of the above principles of design would shorten the Warren boards by 30 per cent. The future control room might comprise a bank of airplane type instruments and miniature controls, so arranged that a station will be monitored and operated from a control seat.

2. Relocation of the generator hydrogen indicating and signal panel to a location adjacent to the actual hydrogen equipment, to provide guidance for the operator in making adjustments to the hydrogen supply to the generator, and to eliminate the hazard of hydrogen leakage into the control room.

3. Use of pressure transmitting devices, with the sender located at the boiler drum or other pressure point and multiple indicating units in the control room and at other required locations, to avoid danger of a pressure blowout in the control room, with attendant disruption of electrical control circuits.

4. Phase-angle control of tie line loading and frequency applied directly to combustion control as well as to the governor control of the turbine, by employing a two-element master combustion control, the primary element receiving its impulse from the phase-angle control and changing combustion rate simultaneously with changes in turbine loading, and the secondary element working on header steam pressure and correcting this pressure at a predetermined rate.

5. The control room will be rearranged to permit greater visibility of the plant by the control room operator.

6. Further studies of the lighting problems in connection with control rooms.

What It Costs—And It's Worth It

This plant consists of two 30,000-kw nameplate rating generators operated on a continuous basis at 40,000 kw each.

The plant is operated with six operators per shift, and a total force, including supervisors, of 53 men. Accurate cost data on the control room versus conventional design have been compiled, and show the additional cost of the Warren design to be $60,000 or $1 per kw of nameplate capacity. The direct savings accruing from this expenditure is the elimination of two shift operators, evaluated at $35,000 per year total. No attempt has been made to date to evaluate the return represented by faster and more efficient operation of the plant when required, but this has been a sizable amount.

This company is convinced of the economic feasibility of the modified central control room, when it is engineered to meet a specific purpose in a definite plant, and that capital invested in such construction provides a high continuing rate of return on the investment.

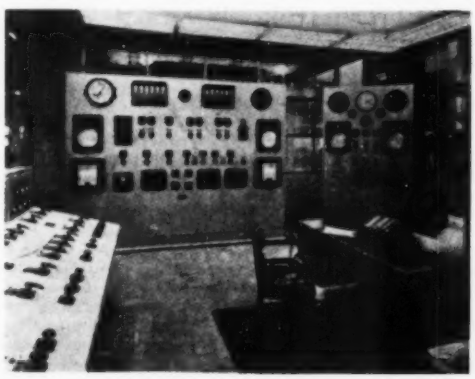


Fig. 3. Relative location and arrangement of station auxiliary power benchboard, boiler panel and master combustion control panel, central control room, Warren Station of Pennsylvania Electric Co.

Power Generation's FEATURE OF THE MONTH

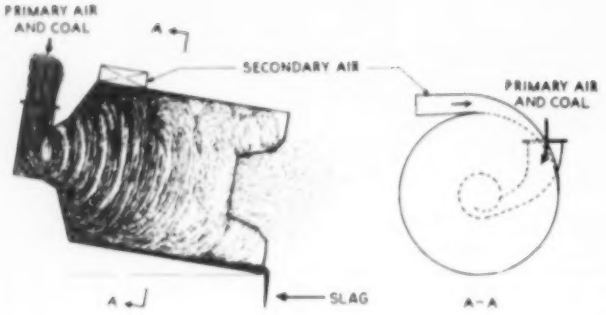


Fig. 1. Schematic diagram showing principle of operation of cyclone furnace. Primary air and crushed coal are introduced tangentially, mixture whirls around and burns in cyclone with secondary air introduced tangentially, and a small amount of tertiary air. Cyclone action coats inside of water-cooled cyclone with molten slag, which traps fuel particles until their combustibles are burned out; molten slag and ash then flow out of furnace for disposal. Combustion gases pass through furnace throat to primary and secondary furnaces of steam generating unit. Cyclone furnaces are installed as shown in Figs. 2 to 9

The Cyclone Furnace—

What It Is, How It Works and

For burning crushed (but not pulverized) coal in steam generating units . . . Designed to permit burning of poorer grades of coal economically with less trouble from ash . . . Does it by utilizing slagging characteristics of coal . . . How coal is prepared and fed to cyclone furnace . . . How much air and how supplied, why unit can operate under pressure with forced draft and often no ID fans are installed . . . How molten slag aids burning, traps 85% of the ash, and is removed . . . Why unit operates with very low excess air . . . Effect on costs of eliminating coal pulverizing . . . Why fly-ash and boiler cleaning are greatly reduced; often no need for dust collectors . . . Kinds of coal cyclone furnace can burn . . . How furnace is controlled . . . Typical installations . . . 54 cyclones installed or being fabricated

By **F. X. GILG**, Application Engineer, The Babcock & Wilcox Co.

HOW CAN poorer grades of coal, our most abundant fuel supply, be burned more economically, and with less trouble from the ash in the coal?

That is a problem that combustion engineers have been studying for many years. The engineers of The Babcock & Wilcox Co., attacked it from the standpoint of utilizing advantageously the slagging characteristics of the ash in coal. After years of development work and testing in the laboratory and pilot plants in the field, the cyclone furnace was perfected. It is the most significant improvement in burning coal since the development of pulverized-coal firing.

What Is It and How Does It Work?

The cyclone furnace is a water-cooled, cylindrical combustion chamber, in which crushed coal can be burned efficiently and completely at high rates of combustion with a minimum of excess air and a maximum recovery of ash as molten slag.

The schematic arrangement of the cyclone furnace is illustrated in Fig. 1. The cyclone furnace is essentially a horizontal cylinder of water-cooled construction, the interior surface of which is lined with plastic chrome ore. Coal, crushed to pass through a No. 4 mesh screen, is introduced, with a portion of the combustion air, at the burner through a tangential inlet that imparts a whirling motion to the fuel particles, which are discharged into the larger cylinder of the cyclone furnace. The whirling or centrifugal effect of the fuel is increased by tangential admission of secondary air at high velocity into the large cylinder.

Combustion proceeds within this large cylinder, with final discharge of gases through a re-entrant, water-cooled throat at the rear of the cyclone furnace. Centrifugal force, which traps the fuel particles in the surface of molten slag covering the wall, provides an intense scrubbing action between air and coal, and prevents the escape of the fuel particles through the discharge throat. As combustible is burned from the fuel particle with high rate of heat release (exceeding 400,000 Btu per cu ft per hr in the cyclone furnace), temperature in excess of 3000 F is developed, the ash constituents are melted into liquid slag which adheres to the cylindrical wall and forms a complete coverage of the water-cooled surface.

The film of molten slag flows gradually toward the tap-hole outlet at the rear, but, because of its viscous nature, the slag movement is much slower than that of the air stream and incoming fuel. The fuel particles therefore are caught and imbedded in its sticky surface and are subjected to an extremely vigorous scrubbing action by the secondary air, which accelerates the

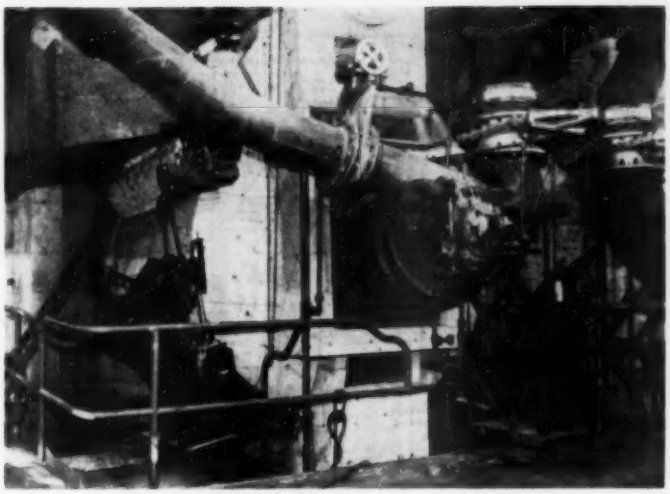


Fig. 2. Close-up view of one of the two cyclone furnaces installed on 400,000-lb-per-hr, 1250-psi, 900 F Boiler No. 13 at West Side Power House, Dow Chemical Co., Midland, Mich. This was completely described in *Power Generation*, March 1949, pages 78-81. This view, taken while construction was still going on, shows pipe at right carrying crushed coal and primary air to cyclone furnace, another pipe coming down at angle from left carrying tertiary air; and, behind it ductwork and dampers (with damper control power drive) for admitting secondary air to furnace. At the new South Side Power Plant of this company, two similar steam generating units with cyclone furnaces are being installed

Latest Thing in Coal Burning

What Results It Produces

rate of combustion. In consequense, the fuel is rapidly reduced to gaseous products of combustion that leave the furnace by way of the throat opening, and to molten slag that drains by gravity toward the outlet tap-hole, for ultimate disposal in disintegrated form by suitable slag-handling equipment.

Recognizing that coal has been and probably will continue to be our basic fuel and that increased dependence will be placed upon the more abundant supply of coals of lower rank and grade, the engineers of Babcock & Wilcox Co. developed the cyclone furnace to utilize advantageously the slagging characteristics of the ash in coal.

Many years of experience with slag-tap furnaces indicated the advantages of retaining much of the ash liberated from coal during combustion in the furnace and tapping it out in molten form. In the light of that experience, it was conceivable that means could be developed whereby still more of the ash could be retained in the furnace. Then the lower-rank coals could be used effectively and efficiently. The fly-ash nuisance could be minimized, and the slag-cleaning problem, so prevalent with stoker and pulverized coal firing, could be largely eliminated.

Another objective was to increase the burning rate of coal so that smaller furnaces could be used. Still another objective was to use crushed coal instead of pulverized coal to reduce the amount of work that had to be done on the coal prior to burning.

In any form of combustion process, it is essential that the reacting substances of fuel and air be brought together with intimate contact, in a zone of high temperature, and in optimum proportions at controlled rates of flow. For the "clean" fluid fuels, such as gas and oil, that is a relatively simple procedure.

Pulverized coal firing, with modern pulverizers and burners and combustion control equipment, closely approaches these fuels as far as ease of effecting and controlling combustion are concerned. However, coal of all grades contains a troublesome constituent in the form of ash, which imposes difficult problems in all stages of the process: fuel preparation, clinkering in com-

EDITORIAL COMMENT

FOR MANY MONTHS now, power engineers have been hearing all sorts of reports about the new cyclone furnace and have been asking us all sorts of questions about it. "How does it work? What does it look like? What's the advantage of it? Can I use it on my boilers? How small a boiler unit will it fit on? Why and how does it reduce the size of a steam generating unit and the cost of cleaning and maintaining it? Will it put pulverizers out of business? How do they get by without dust collectors? Is it true that no I.D. fans are needed?"

To answer these and many other questions, we thought it was about time to have a summing up of the present status of the cyclone furnace—and here it is. It should help all power engineers, whether in utility or industrial plants, to judge where the device stands now and where it's going from here. It should also give you all the basic information you need if and when somebody asks you the industrial $64 question "Can we use it in our plant to help us cut our steam and power costs?"

Fuel adaptability of the cyclone furnace is being well tested. We have seen some of the cyclone units in operation in and near Chicago, burning Midwestern coals. One of the earliest installations went into operation last year in a well-known industrial plant, as described in this magazine, and two others are under construction; and these all burn an Eastern bituminous coal. A unit for an East coast plant, to burn West Virginia coal, is being designed. However, even lignite has been successfully burned in tests on the Calumet cyclone furnace unit described here.

Many engineers have asked us "How small a boiler will the cyclone furnace serve?"—having in mind, of course, its use with industrial plant boilers in the medium size range. We don't know. All we can do is point to the fact that the first commercial unit tested at Calumet Station was rated at 180,000 lb per hr maximum; and that is a relatively small boiler by today's standards. A fairly large number of industrial boilers are rated at around 100,000 lb per hr.

Here in the cyclone furnace is another new tool for the power engineer to employ in his never-ending battle to cut power costs —The Editors.

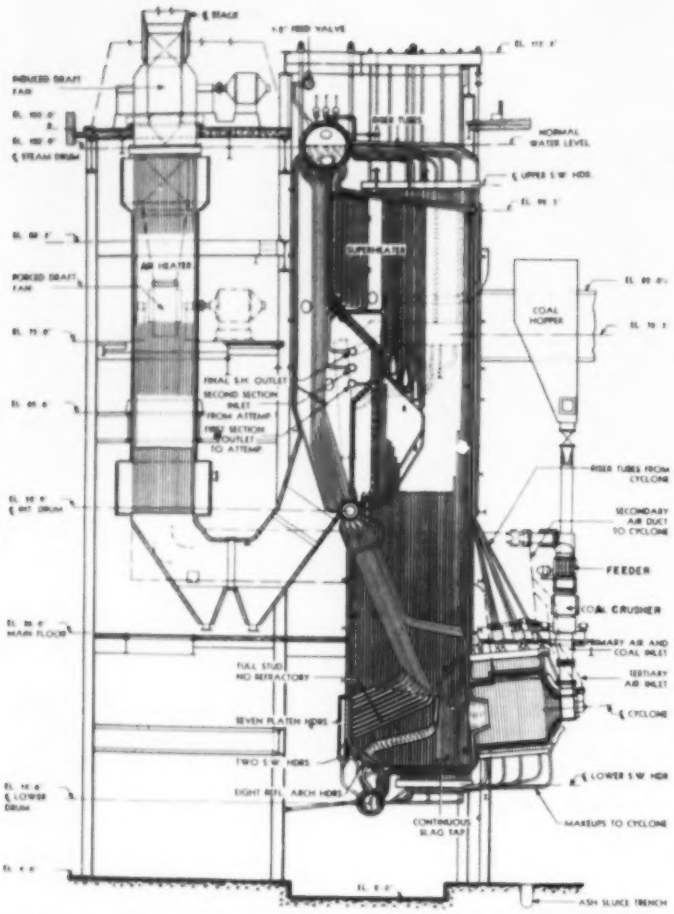


Fig. 3. Cross-section of Unit No. 20A Calumet Station, Commonwealth Edison Co., Chicago, Ill. This is a 600-psi, 900-F unit designed for maximum capacity of 180,000 lb steam per hr.

This was the first commercial cyclone furnace to be installed following intensive laboratory studies with smaller prototypes. Full details of equipment and report on operation were presented in August, 1947 ASME Transactions. In this Calumet unit, thorough tests have been run with a wide variety of coals from different parts of the country, as shown in the table on page 67. These coals have been burned successfully in the cyclone furnace, demonstrating its fuel flexibility.

bustion zones, fouling of steam generating surfaces, and final pollution of gases discharged from the stack. The condition is accentuated with the lower grades of coal which contain more ash; and, in most cases, the fusing temperature of this ash is lower.

With these factors prominently in mind, the idea of the cyclone furnace was conceived. It was based upon the premise that, with high rates of heat release, the complete fusion of the ash to a liquid which could be retained for a short time within the furnace and discharged in easily handled form, would result in cleaner gases passing through the boiler and to the stack. Cleaner gases would reduce the need for cleaning of stack gases before their discharge to the atmosphere, permit a reduction in size of boiler equipment for a given steam-generating capacity, and would require minimum labor for cleaning of heat-absorbing surfaces.

Laboratory Studies with Small Furnaces

Initial studies were made in the Babcock & Wilcox Co. laboratory, using a small furnace 1 ft in diameter, and results appeared so promising that a larger water-cooled furnace 3 ft in diameter was promptly undertaken. With the 3 ft diameter furnace, many conditions were explored relating to general position, air velocities, location of ports and design of burner. Various types of coal were tried, and design factors for larger capacities were established.

As an outcome of this work, a larger 5 ft diameter cyclone arranged in horizontal position was constructed, with its outlet connected to a temporary water-cooled furnace for facility of gas and slag disposal. Quantitative tests were run on this pilot unit, burning principally the local Ohio coal, and specific performance was measured in test runs of from several hours to several days duration with results that continued to show great promise for commercial application.

The Commonwealth Edison Co., and Sargent and Lundy, consulting engineers, of Chicago had followed the pilot plant work very closely and were interested in the possibilities of this unit for handling the high-ash, low-fusing-temperature Illinois coal normally used in the plants of their system. It was decided to go ahead with a commercial scale unit for a practical demonstration of the advantages of this method of firing, and such an installation was made at Calumet Station. The application of an 8 ft diameter cyclone furnace to the complete steam generating unit is shown in Fig. 3.

This installation was first put into operation in September 1944, and has been fully described in a paper* by Grunert, Skog and Wilcoxson that includes a comprehensive review of the operating experience during the first two years of service. In the succeeding years to the present date, the unit has continued in dependable plant service at Calumet Station.

Description of Calumet Unit

As shown in Fig. 3, combustion gases from the cyclone throat are deflected toward the primary furnace floor by the water-cooled division wall and then pass upward through a furnace screen to the secondary furnace, continuing through the superheater, convection pass, and air heater to the induced-draft fan and stack. Thus the products of combustion pass to the water-cooled secondary furnace in

* The Horizontal Cyclone Burner, by A. E. Grunert, L. Skog and L. S. Wilcoxson; *Transactions of ASME*, August, 1947, pp 613-634.

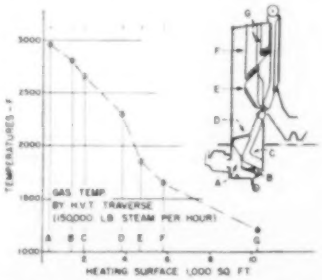
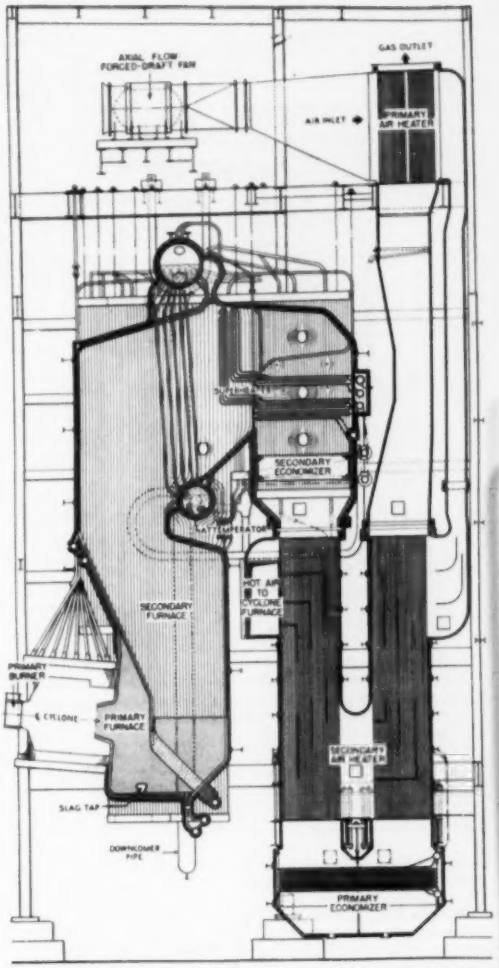


Fig. 4. Temperature traverse taken by water-cooled thermocouples showing the temperature reduction in the Calumet unit

Fig. 5. Cross-section of cyclone furnace steam generating unit for a chemical plant power house. Three such units are being installed

DESIGN DATA, Fig. 5

Three Steam Generators	B & W
Maximum Continuous Capacity, lb per hr each	400,000
Design Efficiency, %	90.9
Design Pressure, psi	1400
Operating Pressure (S.H. Outlet), psi	1250
Total Steam Temperature, F	830
Number of Cyclone Furnaces	2—8' 0" Dia.
Coal	Eastern Bituminous
Btu per lb (as fired)	13,884
Ash Softening Temperature F (reducing atmosphere)	2320



a substantially clean condition.

From cumulative weights of slag collected over a period of 17 months, it was established that the ash content of the products of combustion leaving the unit approximates only 10 per cent of the ash originally in the coal.

About 85 per cent of the ash in the coal is tapped out as slag and about 5 per cent represents "ash shrinkage," the volatilization of some ash constituents due to the extremely high temperatures in the cyclone furnace. It should be noted that the ash content of coal, by ASTM methods, is determined in an air-oxidizing atmosphere of 1390 F. In the cyclone furnace, the temperature is above 3000 F.

The molten slag that is discharged from the cyclone tap-hole collects in a pool on the primary furnace floor, from which it drains continuously through a secondary tap-hole in the furnace side wall into a water-filled slag tank and is easily handled and disposed of.

How Are Cyclone Furnaces Installed?

Cyclone furnaces, completely assembled in the manufacturer's shops, are attached to the lower end of radiant type furnaces as shown in Fig. 5 to 9 inclusive. A steam generating unit, designed to generate 600,000 lb of steam per hour, would require three cyclone furnaces, arranged side by side. The re-entrant throats, one for each cyclone furnace, are part of the front wall of the radiant type furnace. The

Table giving summary of coal analysis data, test coals fired in cyclone furnace, Calumet Station, Commonwealth Edison Co., Chicago

Test Coal		1	2	3	4	5	6	7	8	9
Coal Name		Kincaid	Poca-hontas	Spring-dale	Jeffco Carbon	Ziegler Dust	Fairmont	Poplar Ridge	Midvale	Velva Lignite
Source		Cent. Ill.	W. Va.	W. Pa.	So. Ill.	So. Ill.	W. Va.	(W) Ky.	Ohio	N. Dakota
Moisture %		15	3	5	11	11	4	5	10	38
(Dry Basis) Volatile Matter %		40	25	34	33	33	37	36	39	47
(Dry Basis) Fixed Carbon %		45	67	51	52	49	52	51	47	44
(Dry Basis) Ash %		15	8	15	15	18	11	13	14	9
Btu per lb		11,800	14,400	12,800	12,060	11,520	13,300	12,600	12,350	11,000
Btu per lb (As Fired)		10,030	13,950	12,160	10,730	10,260	12,770	11,970	11,100	6,820
Coal Ash Fusing Temperature, Deg. F.										
	Reducing I.D.	1,950	2,160	2,400	2,140	2,070	2,050	1,940	2,000	2,270
	S.T.	2,030	2,240	2,550	2,170	2,110	2,130	2,030	2,050	2,360
	F.T.	2,270	2,600	2,750	2,440	2,470	2,650	2,350	2,450	2,500
	Oxidizing I.D.	2,190	2,330	2,540	2,290	2,160	2,340	2,330	2,370	2,340
	S.T.	2,370	2,430	2,620	2,390	2,210	2,430	2,500	2,500	2,400
	F.T.	2,490	2,670	2,800	2,570	2,550	2,760	2,600	2,600	2,560

I.D. = Initial Deformation Temperature S.T. = Softening Temperature F.T. = Fluid or Fusing Temperature

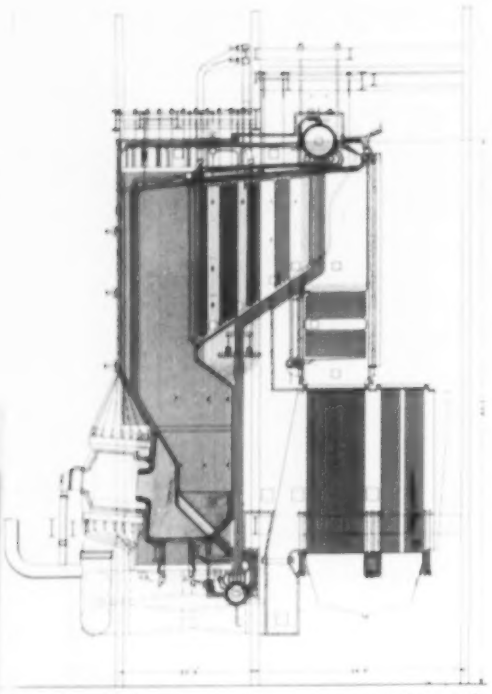


Fig. 6. Cross-section of cyclone furnace steam generating unit for a central station in the Midwest

DESIGN DATA, Fig. 6

Two Steam Generators	B & W
Maximum Continuous Capacity, lb per hr	600,000
Design Efficiency, %	87.04
Design Pressure, psi	1525
Operating Pressure (S.H. Outlet), psi	1325
Total Steam Temp. F	1010
Number of Cyclone Furnaces	3—8' 0" Dia.
Coal	Illinois
Btu per lb (as fired)	10,000
Ash Softening Temperature, (reducing atmosphere)	2000

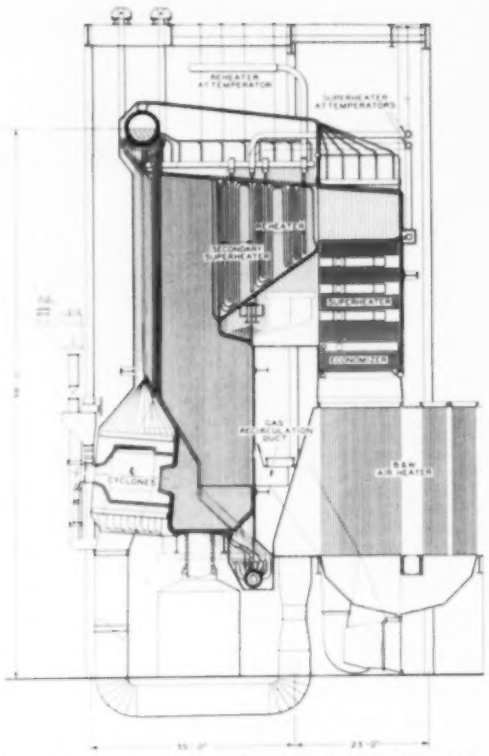


Fig. 7. Cross-section of cyclone furnace steam generating unit for another central station in the Midwest

DESIGN DATA, Fig. 7

Steam Generators	B & W
Maximum Continuous Capacity, lb per hr	830,000
Design Efficiency, %	88.55
Design Pressure, psi	2060
Operating Pressure (S.H. Outlet), psi	1850
High Pressure Steam Temperature F	1010
Reheat Steam Temperature, F	1010
No. of Cyclone Furnaces	4—8' 0" Dia.
Coal	Illinois (also Kentucky & Ind.)
Btu per lb (as fired)	10,000
Ash Softening Temperature, F (reducing basis)	2000

water-cooling tubes of the cyclone furnace are arranged as vertical semi-circles, collected in headers above and below the cyclone furnace. These headers are connected directly into boiler and furnace wall circulation. Thus the entire water-cooling system operates under natural circulation.

The cyclone furnace is a complete unit with fuel, air and circulation connections. However, primary and secondary furnaces are required to enhance the collection of slag and to reduce the temperature of the products of combustion.

A water-cooled division wall in the lower part of the boiler furnace separates the furnace into a small primary furnace and a large secondary furnace. Combustion gases from the cyclone throat are deflected toward the primary furnace floor by the water-cooled division wall and then pass upward through screen and platen-tube arrangements to the superheater, economizer, air heater, and stack.

Combustion is completed in the cyclone furnace at temperatures above 3000 F. The water-cooled walls of the primary and secondary furnace provide heat-absorbing surface that reduces the temperature of the products of combustion to satisfactory limits before they enter the convection surfaces. See Fig. 4.

What Kind of Coal Can Be Burned?

In order to determine the fields of coals that can be burned successfully in the cyclone furnace, tests have been run on the Calumet unit using coals from different parts of the country. During the war years and subsequent period of strikes and coal shortages, it was necessary to bring into the station many different types of coal. Mixtures of these were handled by the cyclone furnace with no conspicuous changes in performance. Subsequent to 1946, however, arrangements were made for delivery of special shipments of several different types of coal for test observation in the cyclone unit. To date, nine of these coal-burning trials have been run, the coal quantities being substantially large—from 2- to 20-car-load quantities.

Each test coal was handled individually through car dumper and elevator equipment to the main bunker, which was emptied of all coal previously used. During each run, observations were made of furnace conditions, particularly as related to behavior of the slag. Many samples were taken for analysis, including raw and crushed coal, slag from primary and secondary taps, and fly-ash discharge to the stack. The unit was run at full load during the day and at partial load for extended periods, and with various conditions of excess air and air velocity.

Furnace performance, as related to slag disposal, was found to correspond quite consistently with the

index of the softening temperature of ash as determined in a reducing atmosphere.

A means of comparing all of the test coals in terms of their ash characteristics is provided by the accompanying table. The test coals have been labeled No. 1 to 9 in chronological sequence of tests. Coal No. 1 is the normal Kincaid, Central Illinois, coal used at the station. The table shows coal ash fusing temperatures as determined by cone fusion test in a reducing atmosphere, as well as in an oxidizing atmosphere in a laboratory.

The coal ranged from medium-volatile bituminous to various grades of high-volatile bituminous and lignite. Four of the shipments were of small sizing, representing screenings from mine preparation. Ignition and burning characteristics were excellent in all cases. The unit was operated with excess air below 10 per cent without a trace of smoke or CO at furnace outlet. Dust loading of stack gases was, in general, lower than when Kincaid coal was burned, and for the several tests showed some correlation with ash content of the fuel and with slag-fusing temperature.

It should be noted that combustion air temperature was limited to about 460 F at Calumet. Higher air temperature will materially increase the range of fuels that can be burned successfully in the cyclone furnace. This has been demonstrated more recently with air temperatures as high as 685 F on the lignite coal test (Test Coal No. 9 in table).

Although other factors are involved, it appears at the present time that the only coals that cannot be burned successfully in a cyclone furnace unit are those with extremely high ash-fusing temperatures, or very low volatile content. Thus, steam generators with cyclone furnaces, can utilize a variety of coals which are economically available.

Fuel flexibility is enhanced still further by the fact that oil and gas fuels can be burned in a cyclone furnace.

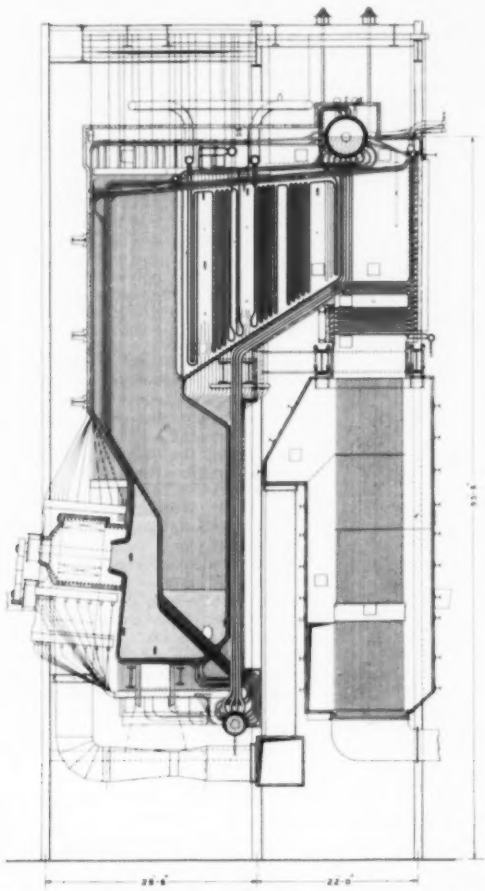


Fig. 8. Cross-section of cyclone furnace steam generating unit for still another central station in the Midwest

DESIGN DATA, Fig. 8

Four Steam Generators	B & W
Maximum Continuous Capacity, lb per hr each	730,000
Design Efficiency, %	87.1
Design Pressure, psi	2125
Operating Pressure (S.H. Outlet), psi	1900
Total Steam Temperature, F	1050
No. of Cyclone Furnaces	4—8' 0" Dia.
Coal	Illinois
Btu per lb (as fired)	10,000
Ash Softening Temperature, F (reducing basis)	2000

What Coal Preparation Is Necessary? How Is Coal Fed to Burners?

Preparation of coal for burning in a cyclone furnace consists of crushing the coal to about ¼-in. size. In some plants, this crushing is done in a coal crusher, which discharges coal directly into the cyclone furnace with the primary air stream. This is called the direct system and requires a feeder and crusher for each cyclone furnace. This arrangement has some advantages in fitting local space conditions and existing coal-handling facilities.

In other plants, and particularly in new plants, coal is crushed to size before it is delivered to the main bunkers. This is called the indirect system. Economics generally favor the indirect system because it permits more efficient use of larger and fewer crushers. In addition, a temporary breakdown of a crusher would not affect the continuous high-load output of the unit.

In either case, the supply of coal to cyclone furnaces is regulated by changing the speed of the feeder.

The cost of crushing coal to about ¼-in. size for the cyclone furnace is considerably less than the cost of pulverizing coal to the usual standard of 70 per cent through a 200-mesh screen. However, this is not all net gain, because of the power consumed by the forced-draft fan in delivering combustion air at approximately 35 in. H_2O to the cyclone furnace.

Air Supply Requirements

The air required for complete combustion in the cyclone furnace is supplied as primary, secondary and tertiary air. The pressure of the air must be sufficient to overcome the pressure drop of the system, which includes a pressure drop of approximately 35 in. H_2O across the cyclone furnace at full load. The temperature of the air should be as high as the economics of the layout will permit. The quantity of air required for complete combustion (primary + secondary + tertiary) is only 10 per cent more than the theoretical quantity required.

The cyclone furnace lends itself to simple combustion controls. The master controller regulates the supply of fuel and air in parallel to suit the load demand. As explained before, the coal rate is controlled by feeder speed. The air supply is regulated by dampers or fan speed or both, in conventional manner.

The range of load on a cyclone furnace is from 2 or 3 to 1, depending upon coal analysis and temperature of air for combustion. On multiple-cyclone units, the range is extended considerably by taking one or more cyclone units out of service.

The cyclone furnace is lighted very easily with an oil or gas lighting torch. The coal fines that segregate from the whirling in the cyclone provide ready means of ignition. A permanently-installed gas lighting torch, or a retractable oil lighting torch, inserted in the secondary air port, ignites the fines in suspension. Flame is stabilized almost immediately. During the hundreds of start-ups to which the cyclone furnace has been subjected thus far, with various coals, each start-up has been readily accomplished without flare-backs. During the five years of commercial operation, under all conditions of load, cyclone furnaces have had an enviable safety record.

Maintenance and Repair

Very little maintenance and repair are necessary in a cyclone furnace unit because there are no moving parts and it is completely water-cooled. The water-cooling tubes are provided with sufficient circulating head. Actually the heat-input rate in the cyclone furnace tubes is not as high as the heat input rate in the tubes of the primary furnace, because of the insulating effect of the layer of slag and the relatively dense layer of the coal-air mixture being whirled against the walls.

The burner-scroll liners, at the inlet to burner where the coal-air moisture is whirled tangentially, are water cooled. The burner-scroll liners can be replaced while the unit is in operation, individual cyclones being shut down during the replacement operation.

The crushers generally require no replacement over a year's service, and the replacement can be timed with scheduled shutdowns. In emergencies, even in the direct system, continuity of steam generation is not affected, for individual crushers and cyclones can be shut down, if necessary.

Typical Installations

Figures 5 to 9 show some typical installations with pertinent design data. A total of 54 cyclone furnaces are installed or are being fabricated for 22 steam generating units.

The units shown on Figs. 5 to 9 are significant because induced draft fans have been eliminated. This is an important new trend in steam-generator design, helped materially by high ash retention in cyclone furnaces and the comparative freedom from deslagging operations. The products of combustion are forced through the unit under pressure created by the forced draft fan. This arrangement not only eliminates the cost of the induced draft fan and its maintenance but operating costs are lowered due to higher fuel efficiency (air infiltration eliminated) and lower total fan power.

Summary of Advantages

Cyclone-furnace-fired units offer attractive advantages in being able to burn lower grade coals efficiently and economically. The advantages contributing to over-all low-cost steam generation are:

1—High boiler efficiency due to operation with lower excess air, better absorption due to cleaner surfaces, and negligible loss of unburned combustible.

2—Safety in operation. Easy to light off. Ignition is stable under all load conditions.

3—Lower first cost and operating cost because expensive de-slagging equipment is not necessary. Simple soot blowers, to remove dust from heat-absorbing surfaces, will suffice.

4—Lower first cost and operating cost due to elimination of induced-draft fans.

5—Lower first cost and operating cost in dust-collectors. In most cases, dust collecting equipment will not be required. Where dust collectors are mandatory, a simple, low-cost dust collector will suffice.

6—Lower cost due to simpler automatic combustion control equipment.

7—Low coal preparation cost due to coal being crushed, instead of pulverized.

8—Low maintenance costs due to water-cooled construction and absence of moving parts.

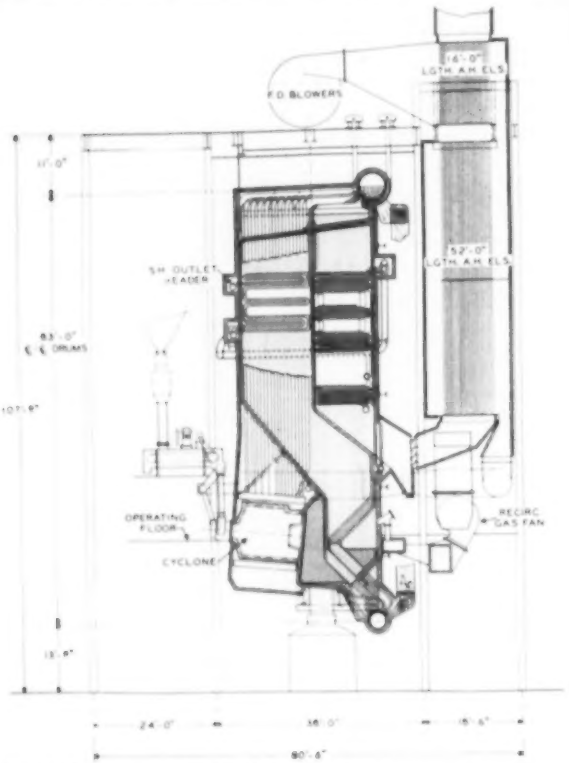


Fig. 9. Cross-section of cyclone furnace reheat steam generating unit for installation in a central station on the Eastern seaboard

DESIGN DATA, Fig. 9

Steam Generator	B & W
Maximum Continuous Capacity, lb per hr	475,000
Design Efficiency, %	89.6
Design Pressure, psi	1850
Operating Pressure (S.H. Outlet), psi	1700
High Pressure Steam Temperature, F	1000
Reheat Steam Temperature, F	1000
No. of Cyclone Furnaces	2—9' 0" Dia.
Coal	West Virginia
Btu per lb (as fired)	13,000
Ash Softening Temperature, F (reducing basis)	2300

Refining and Production of FUEL OILS

This is the first of several articles by the author on the general subject of fuel oils. Each article, while discussing a particular characteristic of fuel oil, will be complete in itself. In this first article, Mr. Schmidt describes briefly the methods used in refineries for producing the various types of oils and distillates commercially available

By PAUL F. SCHMIDT,

Allied Oil Company, Inc., Cleveland, Ohio

THE REFINING of crude oil to produce fuel oils is divided into three different processes; straight run distillation, thermal cracking, and catalytic cracking. This short summary of these refining methods, will be described simply and fundamentally, so as to furnish a little knowledge on the production of fuel oils, which is essential in understanding many of the tests, characteristics, and significances of these oils.

Straight Run Refining Process

The first step in the refining process, is heating the crude oil, thereby converting it into vapor. These vapors are then condensed back into liquid form, but the refining equipment is so constructed, that these vapors are condensed at various levels, in the fractionating tower. This is a tall, cylindrical tower, varying in sizes, but approximating 4 to 6 ft in diameter, and 80 to 100 ft in height. Inside this tower, there are bubble trays, which consist of baffles that permit the vapors to pass through and upward, but retaining the condensed liquids, which in turn flow out of the tower, into the storage tanks. The lightest material condenses at the top, and as we go downward in the tower, the material becomes heavier. This is an extremely simple explanation of the process, but the principle is shown, thus giving an idea of this refining method.

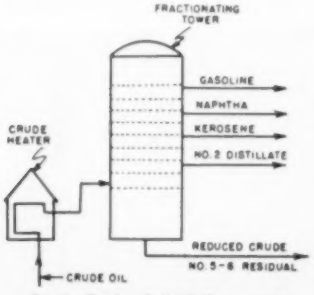


Fig. 1. Crude oil distillation process straight run method

Starting from the top of the tower, these fractions of the crude, or different oils are obtained.

Gasoline
Naphtha
Kerosene
No. 2 distillate
No. 5 or 6 fuel oil or residuals, also called reduced crude.

The types of oils shown, are not the only ones that can be obtained, as the refiner can regulate his equipment to change the types of products produced. As these materials come directly or straight from the crude oil, they are called straight run oils. This straight run refining is only a physical reaction, as the crude oil is composed of oils with various

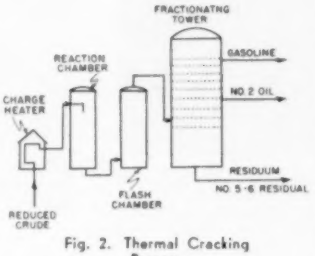


Fig. 2. Thermal Cracking Process

boiling temperatures, ranging from approximately 70 to 1000 F, and by this refining method, the oils are separated from the crude, due to their different boiling temperatures.

This simple crude oil distillation is the fundamental separation process, on which the following or subsequent refinery processes or steps are based. In many cases these fractions or oils produced by this method, are marketed without any additional processing. These same oils are also used in a number of other refining processes, especially as starting material for the various cracking processes. The straight run method is sometimes called, topping or skimming.

The other refining method is called cracking. This method is divided into two distinct types; namely, Thermal and Catalytic cracking. The latter method is more modern and efficient, but thermal cracking will be discussed first.

Thermal Cracking Refining Process

The material for cracking is the straight run product, obtained by the first mentioned process. In the

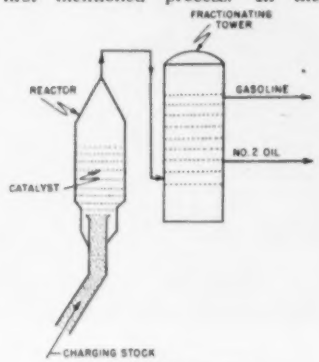


Fig. 3. Catalytic Cracking Process

cracking of these straight run oils, usually the heavy reduced crude, the method is almost the same as in the initial process, the only difference being the use of a higher temperature and higher pressure. It is from this high temperature, that the process is called thermal cracking.

The starting material is first heated in the charge heater, and from there it goes to the reaction chamber, whereby, with the use of these increased temperatures and pressures, the oil is broken or cracked into lighter and heavier materials. Chemically speaking, the molecule of straight run oil is split and broken apart, creating smaller or lighter molecules, while also creating larger or heavier ones. The light ones are formed because a small piece of a large molecule is broken off, while the remaining portion unites with another one of large size, forming a heavier molecule, than the original one.

The cracked products then go to the flash chamber, where the materials are flashed into vapors. These vapors then go to the fractionating tower, where they are condensed, and run to the storage tanks. As in the straight run method, different boiling oils are taken from the fractionating tower at various levels, giving us material, which has different characteristics and specifications, than straight run, and these petroleum products are called cracked oils.

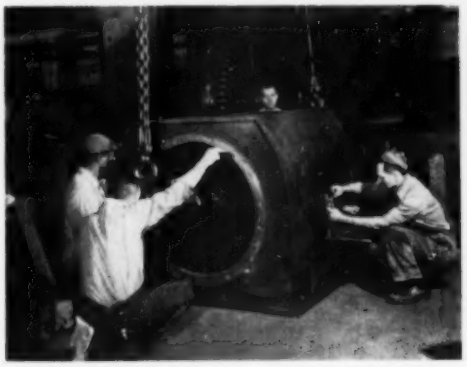
The products usually obtained in this cracking process, are as follows:

Gasoline
No. 2 fuel oil
No. 5 or 6 residual fuel oil

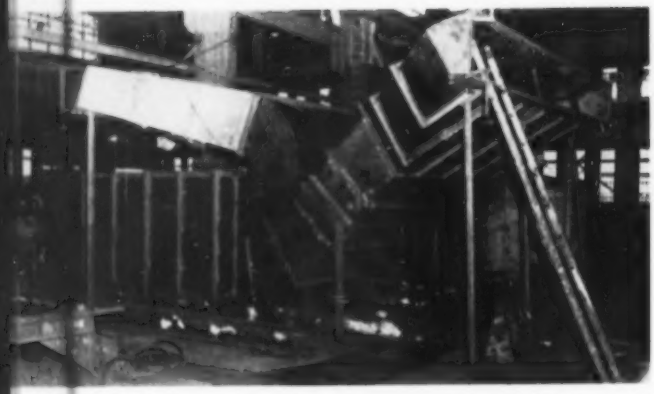
(Continued on page 94)

Power Generation

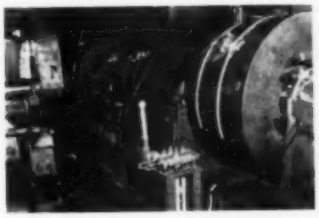
Spectacular 12-ft I.D., 1700-ft long redwood stave pipe line under construction by Santa Fe Tank & Tower Co. at Tokatee Hydroelectric Plant of California Oregon Power Co. on Umpqua River. Pipe required 300,000 board feet of lumber, 272,000 lb steel bands, is built on double curve with 600 ft radius



Slipping rotor into place is crucial step in manufacture of this 2000-hp motor at Sunnyvale, Calif., plant of the Westinghouse Electric Corp. for use on the "Big Inch" pipeline. There is only one-eighth of an inch clearance between the rotor and the stator surrounding it. Accurately balanced to eliminate vibration, and mounted on specially-lubricated bearings, rotor will turn at 3600 rpm

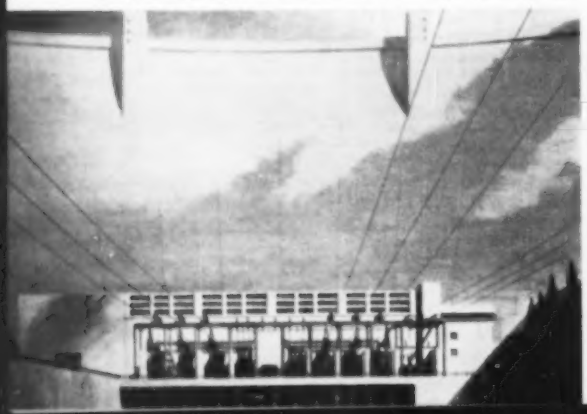


Half of a complete hot air duct for a steam generating unit, being assembled in shop, then knocked down and shipped. This is one of four complete duct units required for two 670,000 lb-per-hr Combustion-Engineering-Superheater steam generating units now being installed at Dunkirk Steam Electric Station of Buffalo-Niagara Electric Corp.



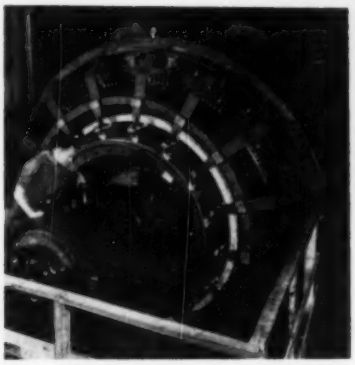
Strain-gaging equipment mounted on equipment under test at National Tube Co., McKeesport, Pa. Gages measure strains and stresses in pipe, tubing and various types of joints while they are being manufactured

Artists drawing showing how Hungry Horse Power Plant, now being constructed by Bureau of Reclamation, will appear. First of four 71,250-kw generators in this plant scheduled to go on line in 1950; full plant capacity of 285,000 kw to be ready by fall of 1953

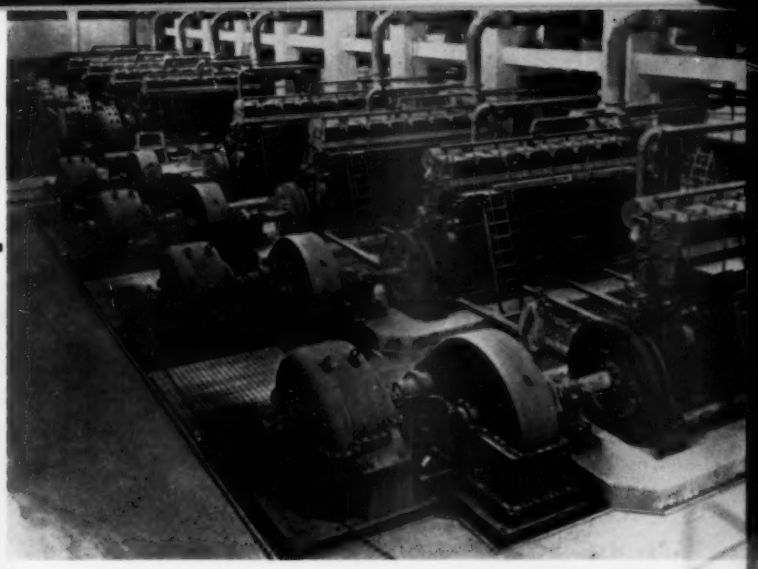


This is 20,000-kw Americana Station, modern hydroelectric plant built in Brazil by American & Foreign Power Co. to serve a 40,000 sq mi area in Sao Paulo. Area was originally settled after American Civil War by emigrating ex-Confederate soldiers, hence the name

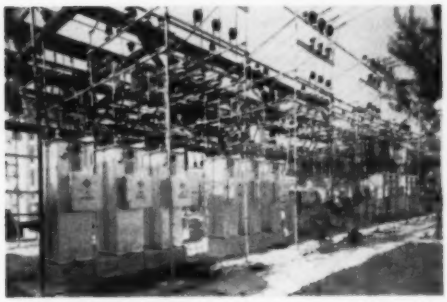
NEWS REEL



Largest twin drive motor unit ever built for steel mill industry is this GE reversing twin-drive unit, each motor a 4000 hp, 30/75-rpm, 600-v reversing motor, directly connected to a 4-high mill of Lukens Steel Co. at Coatesville, Pa.

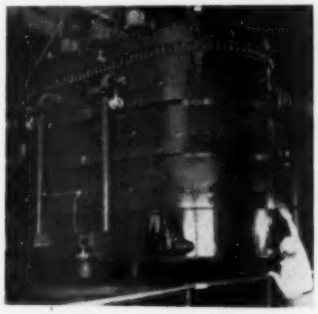


View in Power and Blower Building, Hyperion Activated Sludge Plant for City of Los Angeles, being built at El Segundo, Calif. Nine Worthington supercharged dual-fuel, 8-cylinder, 1688-hp, 360-rpm engines. Each of five engines in background drives Electric Machinery Mfg. Co. 1193-kw a-c direct-connected generator. Four engines in foreground drive centrifugal 3400-rpm blowers through 1:9.45 step-up gears. Engines normally burn raw sewage gas with pilot oil; if gas supply decreases, governors increase oil fuel supply to compensate

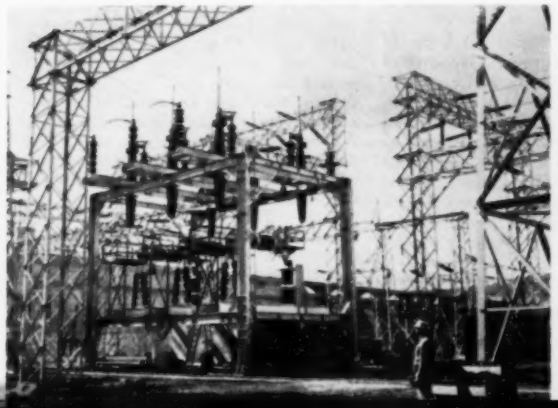


(Left)—Large installation of Allis-Chalmers DFR regulators at a Southeastern utility power plant

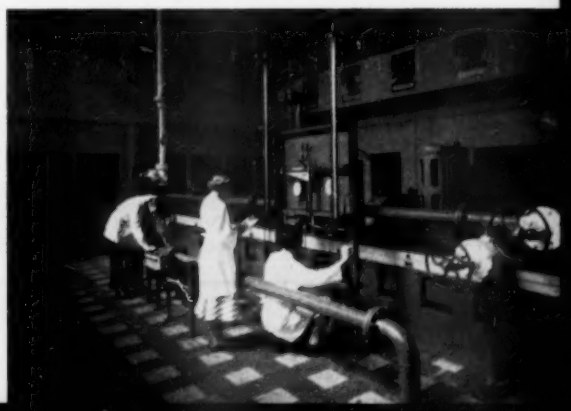
(Right)—Giant 150-ton transformer, the most powerful ever built by the GE at Pittsfield, Mass. First of three transformers for the Detroit Edison Co., this huge unit will raise 15,000 v to 135,000 v. Rated at 145,000 kva, it will handle enough power for a city of 150,000. Improved design made possible 25 per cent reduction in size over comparable ratings in earlier types



Interrupting rating of 10,000,000-kva will be available for the first time on regular power system when thirteen 230-kv GE switching units are installed at Grand Coulee Dam. Two of the units have already been in operation for several months at Grand Coulee. Designed and manufactured for ease of assembly and economy of maintenance. The heart of the switching unit is the three-pole, 230,000-v, 10,000,000-kva low-oil-content, impulse-type power circuit breaker, which can interrupt this power in less than 1/20 sec, reclose in 1/6 sec



Flow testing equipment in new laboratories of Edward Valves, Inc. at East Chicago, Ind. It checks flow and pressure drop through experimental and actual valve designs. It is used in studies to design valves with less turbulence and pressure loss and improved flow characteristics



ELECTRICAL

Don't Underestimate CABLES and POTHEADS

Cables and telephone lines . . . Power cables . . . First termination of power cables . . . Gas-filled cables . . . Varnished cambric insulated cable . . . Rubber insulated cable . . . Improvement of cable terminations . . . Special types of cables . . . Typical cable connections . . . Selection of entrance fittings . . . Fitting conduit terminations . . . Cable capacity and pothead choice . . . Importance of stress relief . . . Precautions with special cables

By **H. H. ACKMANN** Switchgear Section, Allis-Chalmers Mfg. Co., Milwaukee, Wis.

The trite saying that a machine is no stronger than its weakest link is highly exemplified by electrical transmission and distribution systems. No matter how much thought, care and effort has gone into the design and construction of certain elements in the system, if there is one weak place in the system, it will fail at that point. As the author of this article points out, during the last three decades a great amount of development has gone into the improvement of high tension cables but there has been a tendency to ignore or underestimate the importance of properly terminating these cables. Not a great deal has been written in the literature on this subject, so, this article by Mr. Ackmann should be of value and interest, particularly to those who may not have given this aspect of transmission the attention it merits

CABLES and their terminations are as important to efficient and economical power distribution as the major pieces of electrical equipment they service. In spite of this, however, they seem to be relegated to secondary importance. Some of the costly mistakes made in coordinating electrical equipment with the physical structure of the building in which it is installed and with the conduits and cables connecting electrical equipment suggests that this phase of electrical installation is frequently completely disregarded.

This tendency to underestimate the true value of cables and their terminations may be due to ignorance or negligence. This assumption is strongly suggested by the numerous unnecessary failures and inefficiencies uncovered in many actual installation tests. In every case these extra costs and delays could have been eliminated had proper cables and cable terminations been specified at the time of original installation. This can only be done when characteristics and functions of cables and their terminations are fully known.

Cables and subsequent terminations were the direct result of the popular acceptance of the telephone. As its use spread, the telephone companies realized the need for clearing telephone line congestion on poles which carried numbers of lines beyond their physical and economical limit. Insulating each conductor and enclosing a number of them within a lead sheath eliminated this difficulty. Consequently, cables could be pulled through conduit underground, or hung from a steel cable on ordinary telephone poles which, heretofore, had been carrying the aerial bare copper conductors.

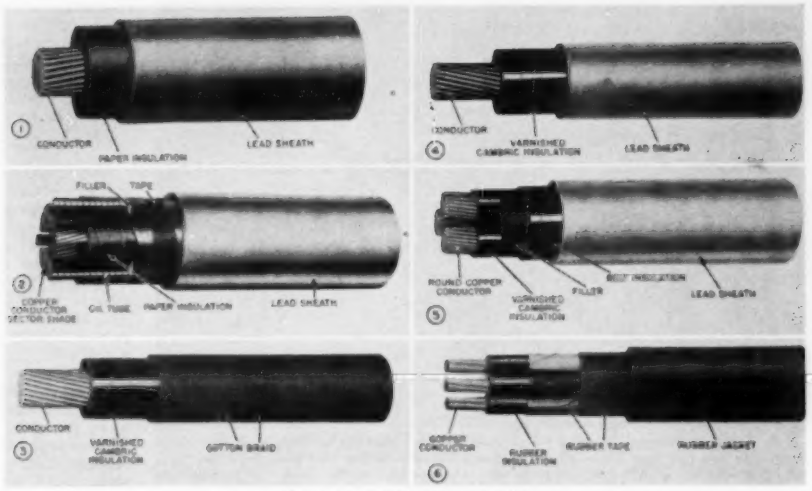
Elimination of one problem gave rise to another. This time moisture seeped into the paper insulation under the lead sheath. To prevent moisture seepage, engineers devised paraffin-filled splice joints and sealed the ends of cables with a cast iron pot which was wiped on to the lead sheath and filled with paraffin. This was the beginning of cable termination, and the origin of the term "pothead."

Power cables followed telephone cables by several years, since power consumption was small and the number of consumers did not necessarily dictate the number of conductors. Their initial problem was not as acute, since they could use the same conductors for many customers.

In time, power distribution systems in large cities required larger conductors. As overhead space became costlier, power companies also recognized the economic advantage of installing conductors underground. Since no other cables were available at that time, they relied upon telephone cable manufacturers for their requirements.

That the original cables were unable to meet power needs became apparent almost from the start. Since the voltage impressed on the conductors of power cables was greater than that of telephone circuits, the effects of moisture were even more disturbing. Experiments revealed that paper was an excellent dielectric when treated with oil. So conclusive and successful was this development that to this day high voltage cables (Fig. 1) are still all paper insulated.

Progressive as it was, use of oil as an impregnating solution for paper only complicated matters for power cable users. They found that unless the lead sheath was completely sealed at both ends and at the splices, the cable oil would run out and air with moisture would seep in. As a result, the dielectric strength of paper was reduced until a flashover occurred either between phases or between conductors and the lead sheath. Thus, the terminating schemes used by telephone engineers were inadequate for the electrical engineer's needs, and a new



Figs. 1 to 6. Various types of cable

(1) Single-Conductor paper insulated power cable. (2) Three-Conductor oil-filled paper cable. (3) Single-Conductor varnished cambric braided cable. (4) Single-Conductor varnished cambric leaded cable. (5) Three-Conductor varnished cambric leaded cable. (6) Three-Conductor rubber insulated and jacketed cable

and better method of terminating had to be developed.

First Termination of Power Cables

Basically, the first potheads designed for power cables were the same as the terminals used by telephone companies, with one exception; the conductor, with its insulation, was pulled through the porcelain bushing which, in addition to serving as a mechanical support for the conductor, provided a suitable base for building a tape cone for sealing the top of the pothead.

A heavy compound, similar to common roofing tar, was used to fill the pothead. Because it remained hard in almost all weather conditions and retained the oil in the cable, the new pothead solved immediate power distribution needs.

This hard compound remained in use for about 20 years, until gradually increasing voltages introduced new difficulties. Moisture trouble appeared when voltages increased; insulating compounds used to fill potheads became hard and brittle during freezing weather, and an internal flashover would occur when, due to shrinkage, cracks would form in the compound in such a way that the internal creepage distance was lowered to a dangerous point, or when a disturbance on the system caused a surge in voltage.

As long as these hard compounds were used, pothead construction of that period permitted the use of cork or fibre gaskets even though gaskets hardened and retained a permanent set. Higher voltages also brought about the use of oils and softer compounds, such as petrolatum, which the cork and fibre gaskets could not retain. Oils and softer compounds, however, possessed large coefficient of expansion. One of the major developments was the location of pressure oil tanks at the ends and at some of the splices of oil-filled cables (Fig. 2) for maintaining constant pressure and preventing oil leakage.

Except on high voltage cables (15 kv and up), cost of these expansion provisions was prohibitive. This was somewhat relieved by the development of an insulating compound which would not shrink or crack in cold weather, but which was considerably harder than the oils and soft compounds that had been introduced. Although not as easy to hold as the harder compound, this compound simplified gasket shortcomings. The improved gaskets used in today's potheads retain their resiliency under adverse weather conditions for several years. Consequently, the oil impregnated cable can be terminated in a modern pothead with little danger of oils or compounds escaping through the gaskets.

Gas-Filled Cable Introduced

Development of gas-filled cables during the past 10 years posed another problem for designers of potheads. In essence, it is a paper insulated cable with a passage through the insulation for nitrogen gas, which fills any voids that may be present in the insulation. In construction it is similar to the oil-filled, paper insulated cable except that oil is drained and cable is filled with nitrogen. Its main advantage is that a positive pressure is maintained within the cable to prevent moisture seepage whenever the lead sheath cracks or leaks. Any cause of diminishing pressure within the cable actuates an alarm, providing sufficient time to locate and repair damage before the cable fails.

About the time that the gas-filled cable was introduced, ceramic engineers devised a new process of metal coating procelain bushings. A comparatively simple method of soldering porcelain bushings to the metal body of the pothead eliminated all gaskets. This solder-porcelain pothead was first used on gas-filled cables and then applied to oil pressure installations.

Thus, far the discussion has been limited to paper insulated cables, since they were the first lead-covered type developed and because paper insulation is the hardest to terminate and splice. The dielectric strength of paper insulation is higher than that of any other material used for cable insulation, making it suitable for application on the higher voltage cables and on the larger conductor sizes. Because of these properties, paper is selected as the most practical insulation for important circuit cables.

Varnished Cambric Insulated Cable

Varnished cambric insulation is probably used more in general power cable (Fig. 3, 4 and 5) applications than any other cable insulation on voltages between 2.4 and 15 kv. Since its dielectric strength is less than that of paper, a greater insulation thickness is needed for an equivalent voltage. However, its moisture resistance is greater than that of paper. Consequently, joints and terminations are much easier to make. Because the cost of varnished cambric insulated cable compares favorably with others, it is recom-

Fig. 7. Potheads preserve cables from air and moisture seepage at their most vulnerable point. The two three-conductor off-set potheads installed in the rear of a switchgear unit equipped with air blast circuit breakers are only one of a wide variety of terminations

mended for primary distribution voltages.

Rubber Insulated Cable

Natural rubber has been used as an insulation for copper conductors for the same length of time as any other insulation. Because it is not affected by moisture to any appreciable amount, it was not enclosed in a lead sheath until after varnished cambric and paper insulated, lead covered cables were introduced. Lead covering for rubber insulated cables (Fig. 6) was applied principally to protect the rubber insulation from possible chemical reaction in the duct line.

Several types of synthetic rubber compounds have been developed in the past 10 years as substitutes for natural rubber. Most of them, however, lacked the quality of dielectric strength of the original rubber insulation, although their ability to resist weather, abrasion and chemical reaction is excellent. Today, various types of rubber jacketed cables are available having some good insulating rubber compound around the conductors with a synthetic rubber jacket taking the place of the lead sheath for protecting insulated conductors.

Cable Terminations Improve

By far, paper insulated cables require more extreme care in protecting them from moisture than any other previously discussed cable, regardless of the potential impressed on the conductor. Cables insulated with varnished cambric, although not as sensitive to damage by moisture, nevertheless, requires protection in the form of potheads for the ends. For a number of years, potheads were not used to terminate varnished cambric insulated cables, especially on industrial applications. This trend has changed in recent years, due largely to increasing load requirements in larger industrial plants and consequent extensions of cable systems within them.

Another factor which influenced the return of the pothead for terminating varnished cambric insulated cables was the development of lower viscosity cable impregnating compounds. A sealed termination of the pothead type was required to retain the new cable oil or compound in the cable, providing added assurance that cables would perform satisfactorily.

Rubber insulated cables do not require potheads except to protect conductor insulation from the deteriorating effects of weather or chemical action. Cables insulated with rubber, or similar synthetic compounds have not been too practical on voltages over 5000 volts, with the exception of special applications where other than normal conditions exist.

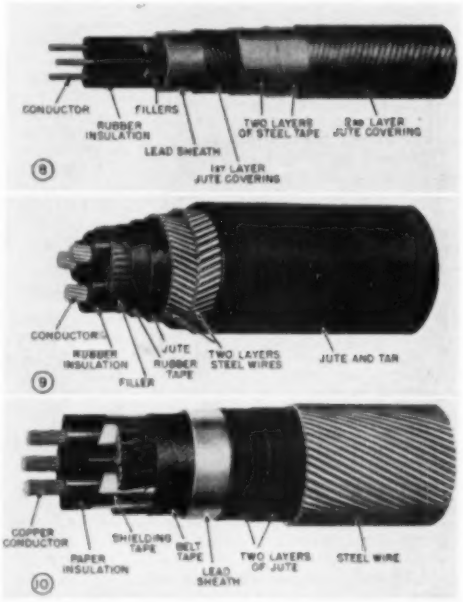
Special Types of Cables

Usually, cables are installed in conduit, either in the building structure or underground. However, there are three types that should be mentioned in all cable discussions. The first, an aerial cable, is of recent origin. It is suspended from pole to pole and supported by a steel cable. The aerial cable has a rubber compound insulation and does not need a pothead.

The second is a direct burial type, trenchlay. The parkway, another direct burial type, is the third. Both were designed for burying directly in the earth, with provisions for protecting conductors from sharp objects. Both have rubber insulation for the conductors. They differ in that the parkway has a lead sheath while the trenchlay cable has not.

The parkway cable (Fig. 8) has a layer of jute over the lead sheath, with two strips of steel tape wound helically over the jute and then covered with an additional layer of tar impregnated jute on the outside to protect the steel tape from moisture and acids that may be present in the soil. The trenchlay covering is similar to the parkway except that there is no lead sheath and, instead of steel tape, a durable fibre tape is used.

Both the trenchlay and the parkway require some sort of termination. A pothead, using a special en-



Figs. 8 to 10. Special types of cable (8) Multi-Conductor rubber insulated parkway cable. (9) Three-Conductor submarine cable. (10) Three-Conductor borehole, mine and shaft cable

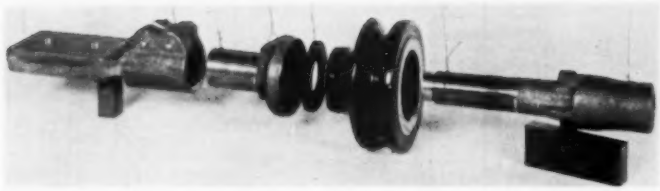


Fig. 11. Pothead Capnut terminal assembly

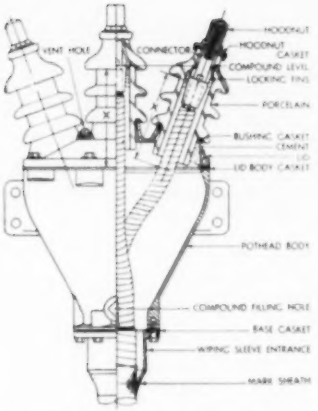


Fig. 12. Straight-Through terminators do not have copper terminals at the top

trance fitting specifically designed for such cables, is the most practical and advisable.

Submarine and borehole cables require special applications, too. Since both are of almost similar construction, they can be terminated in the same manner. The submarine cable (Fig. 9) and the borehole cable, (Fig. 10) are designed for special applications. Their construction consists of any standard cable, which, in turn, is covered with a layer of jute and a helical wrapping of No. 6 or No. 8 galvanized steel wire wound helically around the cable. A layer of tar provides protection against corrosion. The steel wire contributes mechanical support and protection for the power cable on the inside.

Submarine cables as their name implies, are used for underwater installations. Borehole cables are usually dropped vertically through a borehole to an underground substation found in mines or other underground installations. Depending upon its length, the borehole cable may be supported at several points in its drop from the surface of the ground to its termination underground.

Either of these cables requires special treatment for effective termination. Necessary fittings for terminating the wire armor are usually provided with the pothead. These should be obtained from the source before a particular method of termination is selected. Such precautions apply especially in installations requiring submarine or borehole cables.

Typical Cable Connections

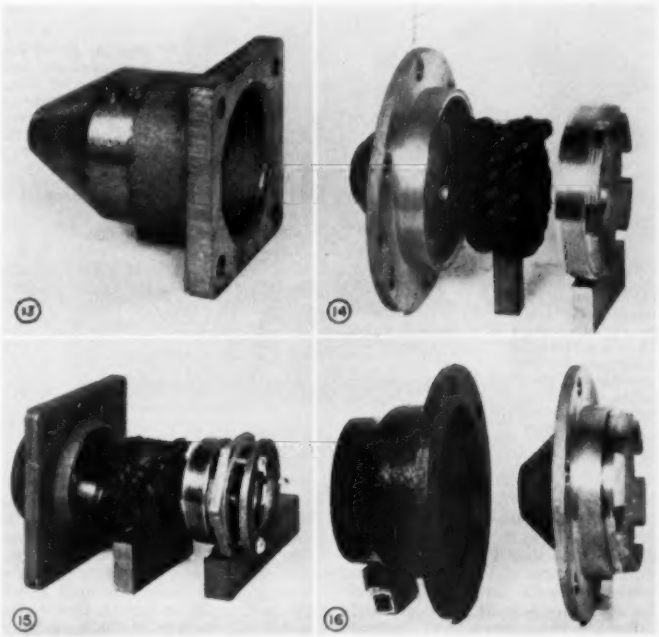
Power cable connections can be made in three ways: a hermetically sealed pothead, an open, compound-filled terminator or application of some sort of copper terminal lug with a method of clamping or supporting the cable. Conditions and installation requirements determine the type of cable termination to be used.

The most common method of terminating is the hermetically sealed pothead. Termination of this sort has a gasket-sealed copper terminal arranged at the top of the porcelain bushing in such a way that the gasket is held under compression. The copper terminal, with its gasket, holds the compound within the pothead and prevents moisture and air from entering in the event a vacuum develops when the pothead and cables are cold.

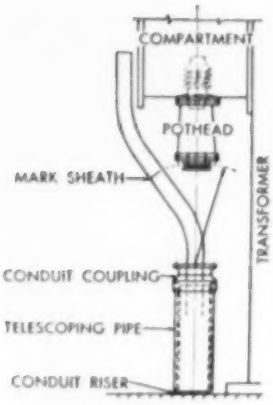
The sealed terminal, or capnut pothead, is available either in the multiple conductor type, with a porcelain bushing and terminal for each conductor, or with only one porcelain bushing and terminal for use with a single conductor cable. The copper terminal of the capnut type of pothead consists of three parts, as shown in Fig 11: internal connector, compression fitting or hoodnut, and an aerial or terminal lug. The internal connector is a copper stud in which the cable conductor is terminated. The hoodnut, or compression fitting, is the external part of the terminal that tightens the gasket against the porcelain bushing to seal the pothead. In order to make a good electrical connection to the terminal, some sort of lug or fitting is usually added to the terminal for terminating the aerial conductor or bus bar. It should be noted that the typical pothead designs were chosen for illustrative purposes only. Potheads used with particular apparatus may vary in construction from those illustrated.

The sealed terminal pothead is generally recommended for paper insulated and varnished cambric insulated cables, particularly on voltages five kv and higher.

Some cable installations permit



Figs. 13 to 16. Types of Fittings (13) Wiping Sleeve entrance fitting for pothead is most commonly used. (14) Exposed Assembly view of stuffing box entrance fitting for pothead. (15) Some Fittings are a combination clamping ring and stuffing box entrance. (16) Stuffing Box entrance fitting and conduit coupling type of termination



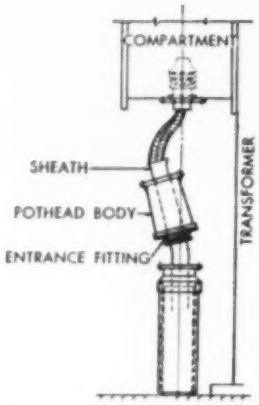


Fig. 17. Slip Joints in conduits are one of the simplest means of providing required flexibility for alignment and clearance on a pothead installation on electrical equipment

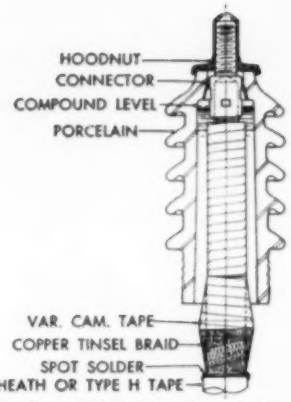


Fig. 20. Stress Relief cones of some type are necessary for proper termination when special cables are used. A typical example of an effective stress relief cone is shown above

cables to be terminated in potheads or terminators which do not have the copper terminal at the top of the insulator. Instead, the conductor (Fig. 12) with its insulation is drawn directly through the cover or insulator. The copper of the cable is terminated in a terminal lug on the apparatus as if a pothead were not used.

Although more economical, easier to install and, on the whole, satisfactory potheads with the open or through porcelain bushings are limited to installations using varnished cambric or rubber insulated cables. Even with varnished cambric insulated cables a certain amount of leakage occurs when load conditions create heat in the cables. Another requisite arising from the application of the straight through pothead is that the ends of the cable should be approximately at identical levels, otherwise the compound at the lower level of the pothead will escape while compound at the other extreme will disappear into the cable. Use of softer cable oils in the manufacture of varnished cambric cables during the past 10 years has aggravated the difficulty of retaining cable oils and compounds in the open porcelain bushing pothead.

Selecting Cable Entrance Fittings

Final choice of pothead determines the corresponding cable entrance fitting. The several types available can be more or less classified into three categories: wiping sleeve, stuffing box and clamping ring.

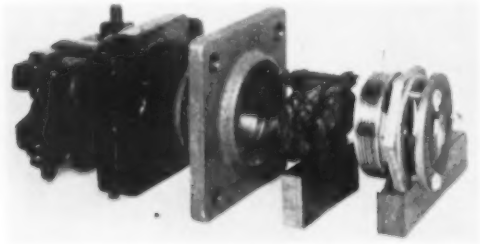


Fig. 18. Direct Burial cables can best be terminated in the pothead when a clamping ring and stuffing box entrance and armor clamp are used to seal the base of the pothead

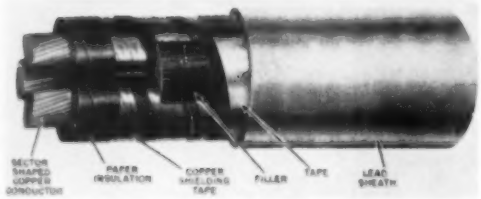


Fig. 19. Paper Insulated power cables for equipment above 15 kv require special treatment in construction and termination to prevent corona and provide good termination

The wiping sleeve entrance (Fig. 13) is possibly the most commonly used and is considered superior to the other two. Essentially, it consists of a brass cone bolted to the base of the pothead through which the lead cable is drawn. Before the remaining portion of the pothead is built, the lead sheath is removed into the wiping sleeve until only about an inch of lead remains inside the cone. After the pothead is assembled, an ordinary wiped joint is made between the lead sheath and the conical surface of the wiping sleeve. This type of cable entrance is reliable and provides a satisfactory electrical bond and a tight seal at the base of the pothead, providing the wipe is properly made.

The most commonly used mechanical cable entrance is the stuffing box shown in Fig. 14. As its name implies, it consists of two metal parts which tend to compress cord packing tightly against the cable when the bolts or threaded portion on the movable part of the fittings are tightened. Although generally considered satisfactory, the stuffing box develops an occasional leak when used to seal potheads containing soft compounds or oil. Other disadvantages of this type of entrance are that it does not effect a good electrical bond between the lead sheath and the pothead body, nor does it provide dependable mechanical support.

Various methods of clamping have been tried to overcome the disadvantages of the stuffing box. One of the most successful is the clamping ring arrangement where the lead sheath is pulled through one metal ring and then belled over and a second ring is then bolted atop the flared lead sheath. The clamping ring grounds the lead sheath of the cable to the pothead body. Unless the thickness of this lead sheath is uniform, there is a possibility of leakage. One of its advantages is that it definitely provides a mechanical support for the cable.

Commercially available potheads use a combination fitting which has the advantages of the clamping ring and still retains the reliability of sealing the base of the pothead at the same time. Known as the combi-

nation clamping ring and stuffing box (Fig. 15), it consists of a stuffing box in which the lead sheath is not only grounded but also clamped at the top of the fitting for considerably increased mechanical support. This combination fitting is more retentive than the ordinary stuffing box. The lead sheath is clamped in such a way that it practically seals the cable and relieves pressure on the stuffing box, retaining any compound or oil which may seep past the clamping ring.

Pothead termination of cables requires some sort of cable entrance fitting. Commercially purchased potheads are available with either wiping sleeve or stuffing box entrances, or either of these can be cut in the field by installation personnel. However, when potheads are purchased, entrances to fit the particular termination should be ordered and the cable specification should be given.

Fitting Conduit Terminations

Sometimes the manufacturer of a transformer, switchgear or a generator finds that it is necessary to mount a pothead on the end of a conduit run. Such an installation would require a conduit coupling with the pothead in the event that the conduit is to be connected to the pothead. A stuffing box, clamping ring or one of the combination clamping ring and stuffing box entrances (Fig. 16) provide the most practical solution. Size of the coupling is determined by the dimensions of the conduit.

There is one danger in an installation of this type which should be guarded against: when conduit is brought directly to a pothead which, in turn, is rigidly fastened to some other piece of equipment two things must be done. First, any misalignment between the conduit, usually encased in concrete, and the piece of electrical equipment must be rectified. Secondly, on an installation of this type sufficient clearance should be assured between the machine and the rigid conduit for the installation of the pothead.

A slip joint (Fig. 17) in the conduit is possibly the simplest method of providing flexibility for alignment and clearance for the installation. The conduit is so arranged that a short length of larger diameter conduit is slipped over the conduit encased in the concrete and, after the pothead is installed, the short conduit is raised and screwed into the conduit coupling on the pothead. Possibly no other condition of a pothead installation has been the cause of more trouble in the field than obtaining desired flexibility which must exist between the equipment and the pothead or cable termination when conduits are employed.

Selection of a pothead for an installation is influenced by the actual size of the copper conductor. Kva or number of amperes that is to be carried by a cable does not necessarily determine the size of the copper conductor. Other factors limit cables that are just as pressing in specifying copper conductor requirements as the actual load.

For instance, cables traveling through well-ventilated and cool underground ducts are usually able to carry much higher ampere loads than cables in a closed conduit run which is encased in a concrete wall next to a hot boiler room. All of these incidental factors should be brought to bear before a pothead is decided upon. Commercially procured potheads, based on specific installation requirements, can be obtained with copper terminals properly bored for soldered connection. Solderless internal connections have been developed for some sizes of cables, but these are physically limited to sizes determined by space inside the porcelain tube.

To complete the termination, the proper type of connection should be made to the top of the pothead terminal. If copper bus bars are used, a blade type of connection will be the most practical. However, if standard stranded copper conductors are to be connected to the pothead terminal, the lugs should be drilled according to the copper conductor dimensions.

Voltage rating of the pothead should be coordinated with the insulation level of the cable. Common practice recommends a pothead having a rating low enough so that the insulator will flashover before the insulation of the cable is broken down.

Direct burial cables afford several ways of terminating. The most suitable, and by far the simplest to make, is the pothead with an armor clamp. This armor clamp shown in Fig. 18 is installed on the base of the pothead in the same manner as the conduit coupling. As with the conduit coupling, a stuffing box or clamping ring type of entrance is required to seal the base of the pothead. The armor clamp can be adjusted within certain limits to the various sizes of cables. However, submarine or borehole cables having wire armor require a special type of armor clamp.

Stress Relief Important

Stress relief exerts considerable influence in any discussion of cable terminations. Normally, stress relief is not required on voltages below the 15-kv class. This type of equipment, as well as cables, requires considerable precautions for preventing corona.

A suitable cable, requiring special treatment to properly terminate the shielding tape or braid used in its construction, has been developed for this voltage range. As shown in Fig. 19, it consists of a thin copper tape wound helically around each conductor of a three-conductor cable over the paper insulation which must be properly handled inside the pothead to make an effective termination. Another paper insulated cable has a layer of carbon coated paper wrapped around the insulated conductor which acts as a shielding tape. Special treatment is again necessary to obtain good cable termination.

Operational difficulties are sometimes encountered when special cables are used. For instance, on one generator installation where the carbon coated paper shielding tape was used in the cable construction, the installation crew either overlooked or did not appreciate the need for removing the shielding tape before completing the termination. The situation was further aggravated by the fact that no stress relief cone was added. Consequently, pothead failures began to occur shortly after the generator began to operate. These persisted until someone found and corrected the omissions.

If efficient, uninterrupted operation is to be obtained, some sort of stress relief cone should be made to properly terminate shielding tape, (Fig. 20) in the pothead. Exact location and shape of the stress cone is somewhat of a controversial issue, and the recommendation of the pothead manufacturer should be followed.

Summary

Cables, entrance fittings, potheads, and the conditions under which they are to be used should be considered seriously before a method of cable termination is chosen as the most practical and economical for an installation. These precautions apply whether an industrial concern has its own engineers supervise cable termination or whether the manufacturer of the equipment is consulted and authorized to provide necessary potheads and accessories. In addition to the preceding requirements, space limitations, location of equipment and anything else that might affect the installation of potheads or cables should be properly evaluated to achieve efficient and economical cable terminations.

IF SOMEONE tells you to get him a stretchable ruler, just act nonchalant and get one. A variable scale 12 inches long, made of anodized aluminum is available. It is fitted with a triangular coil spring which when expanded or contracted, spaces intermediate points proportionately. When fully compressed, the spring has 100 markings to the inch. When used in relation to fixed basic scales, it can solve problems of spacing, proportion and interpolation.

First 5000-kw Packaged Turbine Generator Simplifies Installation

By

A. A. WOODWARD
Assistant Superintendent
Steam Production
Public Service Company of Colorado

and

R. R. KALEY
Steam Service Engineer
Westinghouse Electric Corporation
Denver, Colorado

FIRST 5000-KW Westinghouse packaged power plant to be installed in the United States was brought into commercial service in 1948 by the Public Service Co. of Colorado at Grand Junction, Colorado. This type of steam-turbine generator unit was chosen, partly because of a favorable delivery date, but mainly because it fitted so conveniently into the available space in the existing turbine room.

Demand for electric energy in Grand Junction, Colorado, and the surrounding area had increased remarkably during the past several years. Output of the system had doubled during the last five-year period. In 1948 the maximum hour demand reached was 9500 kw.

Need for Packaged Unit

Until the installation of the 5000-kw packaged generating unit, the area was served by the following facilities showing the need for additional generating capacity.

(1) A 3300-kw hydro plant at Palisade, Colorado, the full capacity of which is available only during the spring and fall months. During the summer period output is cut in half because of irrigation needs; while, during the winter months, plant generation is limited by icing conditions.

(2) A 1400-kw hydro plant serving the Redlands Irrigation Co., from which a varying amount of energy above its own pumping needs is sold to the Public Service Co. of Colorado.

(3) A 3500-kw steam plant located in the City of Grand Junction. This plant has provided the "back-up," firming up the variable capacities available from the hydro plants.

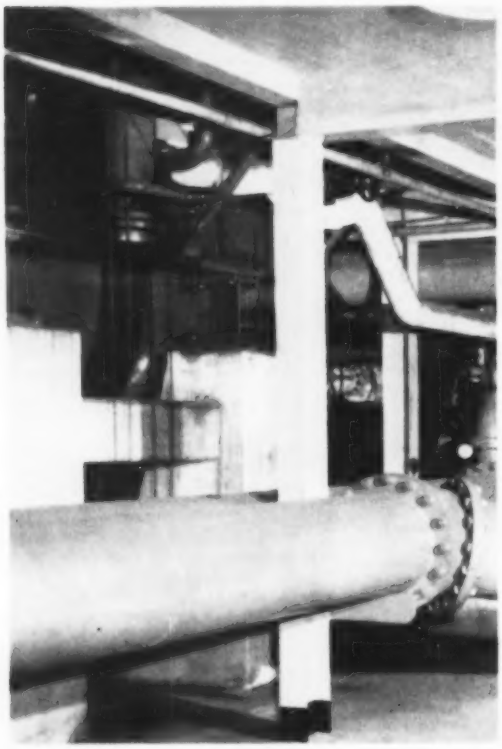


Fig. 1. Eight piers support the 5000-kw turbine generator instead of the more complicated foundations needed for separate mounting

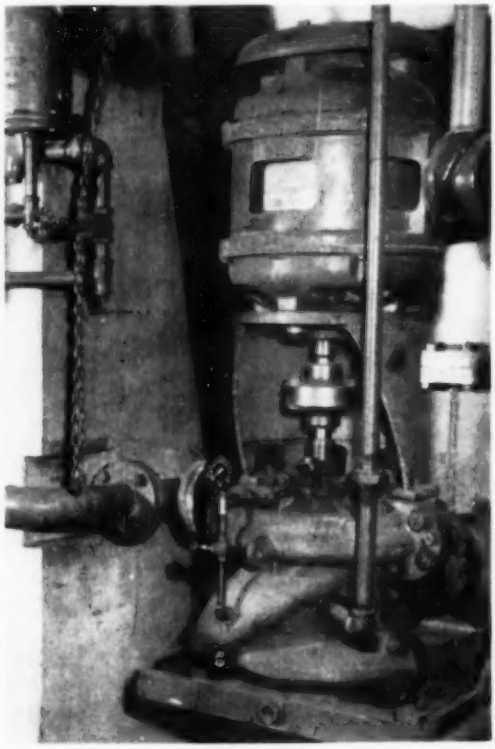


Fig. 2. Auxiliaries such as this two-stage condensate pump are mounted on the condenser, simplifying installation

Most of these sources, with the exception of the 3500-kw unit at Grand Junction, were subject to variations beyond the control of the Public Service Co. Additional firm power was needed quickly to insure an ample supply of power at load peaks. It was desirable that the new unit fit into the existing generating station with a minimum amount or rearrangement of existing facilities. The packaged power unit appeared to have these advantages.

Unit Requires Only Simple Supports

Principal departure from conventional steam turbine design employed in the packaged unit is in the supporting structure. Eight comparatively small piers, such as shown in Fig. 1, support the entire turbine generator unit with the single exception of the circulating pump. Much less excavation and foundation work was found necessary with this method of installation, since existing floor elevations did not have to be maintained. This type of unit was also eminently suited for conforming to the minimum headroom requirements of the Grand Junction Station.

Mounting the auxiliaries on the condenser provides an extremely compact unit weighing in all only 85 tons. These auxiliaries consist of: two air coolers, oil cooler, dual two-stage air ejector with inter and after condensers, vertical two-stage condensate pump (Fig. 2) and a low-pressure, feedwater heater. The turbine, generator, and direct-connected exciter are mounted directly on the upper condenser deck. Axial and lateral expansion is controlled by the use of flexible steel members as shown in Fig. 1. A flexible diaphragm is provided between the turbine exhaust flange and the condenser shell.

Although it was possible to ship the condenser, turbine and generator completely assembled as a unit, conditions at Grand Junction were such as to necessitate shipment of the main parts separately. However, reassembly of the unit was much simpler and faster than is the case with a conventional unit. After the condenser was in position on the supporting piers, the turbine, generator, and exciter were located by using the same dowels that were used for the original assembly in the manufacturer's shops. No change was required to obtain the correct coupling alignment.

Details of 5000-kw Packaged Unit

The package turbine generator set, supplied complete by Westinghouse Electric Corp., consists of the following elements:

The turbine, which is the condensing impulse type, is designed to operate at 400 psig throttle pressure, 750 F total temperature, exhausting at 1½ in. Hg absolute. The generator is rated at 5000 kw, 0.8 pf, 6250 kva, 4150 v, 3 phase, 60 cycles. A

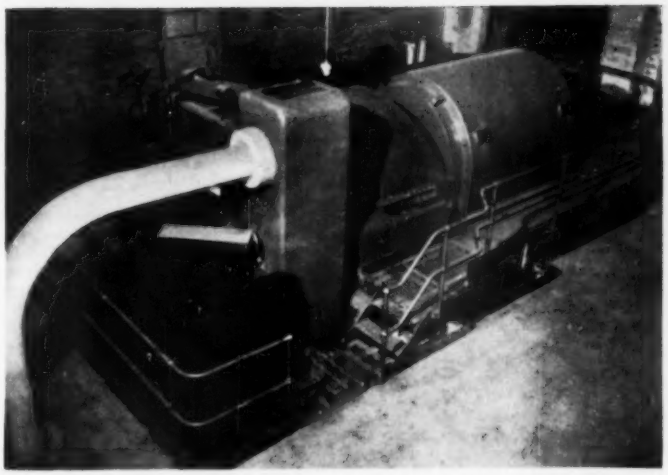


Fig. 3. Turbine, generator, and exciter are also mounted on the condenser, making a complete package that can be shipped as a single unit

radial-flow type surface condenser having 6,000 sq ft of surface is used.

It is equipped with one 6300-gpm centrifugal circulating pump; one 128-gpm vertical 2-stage condensate pump and one 2-stage, twin element steam jet air ejector unit; one low-pressure bleed heater.

The direct-connected 33 kw, 125 v, d-c enclosed exciter is provided with a two-piece removable housing. Cooling air is obtained from the main-generator air cooling system and is returned to the coolers through filters. The exciter brushes can be changed easily and without special tools while the unit is carrying load. This is a desirable feature from an operating standpoint.

The assembled unit is shown in Fig. 3.

The unit has been serving the needs of the system in a very satisfactory manner since its initial operation. For the past 12 months the unit has been in quite continuous operation, totalling 8035 hrs. System conditions, which dictate the maximum use of hydro generation and transmission "take," result in a low load factor for steam-plant operation. Total generation of the above unit for the annual period amounted to 24,999,000 kw hr with a maximum hourly output of 5800 kw.

Where New Unit Gets Its Steam

Steam supply for the new packaged generating unit is provided by a new steam generating unit capable of producing 60,000 lb of steam per hour at 450 psi. Older boilers generating at 150 psi had previously supplied the 3500-kw unit and three old, smaller units. The new boiler is now used for both the new and old generating units. When the 5000-kw packaged unit operates, the old units are shut down. When the packaged unit is shut down, the 3500-kw unit and the three small units are operated from the new boiler, which continues to operate at 450 psi, by reducing the pressure to 150 psi through desuperheating arrangements.

New steam generating equipment consists of one Type F. H. Babcock & Wilcox boiler and superheater, with initial capacity of 60,000 lb steam per hour and future capacity of 85,000 lb steam per hour. The boiler is designed for 450 psig drum pressure. It has four circular horizontal burners for pulverized coal or oil firing. It is of the dry-bottom ash removal type, and is equipped with a B & W air heater, and two type E-21 B & W pulverizers.

Forced-draft and induced-draft fans were furnished by the American Blower Corp., and are arranged for V-belt drive. Capacity of the forced draft fan is 75,000 lb per hr of 80 F air at 950 rpm; induced-draft fan will handle 93,000 lb per hr of 420 F flue gas at 1170 rpm.

A Multiclone dust collector is installed between the gas outlet of the boiler and the inlet of the air heater.

Ashes are removed from the boiler and dust collector with United Conveyor Corp. conveyor equipment.

The boiler feedwater is heated and deaerated by a Worthington 80,000 lb per hr, horizontal, single-element type deaerating heater. From this, 2 Allis-Chalmers type MM, 4-stage centrifugal boiler feed pumps, driven by 85 hp type ZS Terry turbines supply the feedwater to the boiler. Each pump is designed to deliver 100 gpm at 1320 ft total head.

Condenser circulating water cooling is provided by a two-section 5500 gpm Marley, Model 18, B 1 induced-draft, double-flow cooling tower.

Power Usage Diagram Shows Steam Turbines' Part in Pulp Production

EVER-CHANGING balance between the cost of labor and materials on the one hand, and fixed capital charges on the other, have resulted in significant modifications in pulp processing, also in power and steam generation in the pulp mill.

Logs are becoming more inaccessible as forest stands recede. Their cost increases with increased demand and diminishing supply. Necessity for conservation of logs and the excessive labor costs required to clean wood by hand have resulted in the adoption of the hydraulic whole-log barker and chipper.

This device not only materially increases power required per ton of pulp but, with larger whole-log chipper motor, instantaneous electrical peaks are produced, which require turbine generators with governors much more sensitive than heretofore. If the mill is isolated from an outside source of power for regulation, the governors must be sufficiently responsive to damp system frequency variations, so that wide fluctuations in load will result in insignificant frequency changes.

The installation of the hydraulic barker not only increases the power requirements of the mill; it also reduces the amount and quality of waste wood available for fuel. As a result, additional higher-cost supplementary fuel must be purchased. Increase in quantity of power required, and in cost per Btu, justifies most economical heat balance possible and expenditure of larger sums of money to procure most efficient steam and power equipment.

These facts were reviewed by W. O. Stevens, consulting engineer, of Seattle, Wash., in the Autumn 1949 issue of *Powerfax*. He then presented the following data showing how they affected design of a particular power plant.

When the British Columbia Pulp & Paper Co., Ltd. decided to modernize their Woodfibre mill, by building a power plant and installing a hydraulic barker, the new power plant was built as near as possible to the electric and steam load center of the mill.

Minimum over-all power costs required that the potential energy in the mill process water from Cedar Creek, be passed through a wasting-type Pelton wheel to drive a 2650-kva generator. A storage dam was built at the outlet from Henrietta Lake high above the pulp mill, to insure year-round operation of the hydro unit and an adequate supply of process water.

A general revision of load centers and power distribution was necessary. Power generation at 4160 v proved to be the most economical for copper requirements as well as transformer, circuit breaker, and installation cost.

To arrive at optimum number and size of generating units is a complicated procedure in a plant of this type. This is especially true when the fuel to be burned consists of hog fuel from the open market, wet bark from the hydraulic barker, imported fuel oil, and coal, if and when available. In addition, consideration must be given to energy available from the process water as a result of increasing the water storage and installing a hydraulic generating unit.

The pulp mill produces high quality dissolving pulp 24 hr a day and requires steam at 50 psig and 150 psig throughout this period. Maximum electrical load occurs during the 8 hr in each day when the barking plant is operating. Load demand varies from one shift to the next, depending upon whether the barking plant is operating and upon the type of pulp being produced.

One of the older parts of the mill is driven by a mechanical drive hydraulic turbine using water from Mill Creek, which runs through the mill site and is available for producing power during a part of the year. During the dry season this power must be produced by a steam engine drive.

The number and size of generating units to be installed in the power plant to take care of peak conditions and realize the minimum yearly operating and capital costs under any combination of load variations, in the final analysis, became:

1. A 2650-kva hydroelectro unit to be operated from the mill process water from Cedar Creek.

2. Two 2000-kw steam turbine generators with 550 psig, 725 F inlet steam conditions, 150 psig extraction, and 50 psig exhaust.

Provision was made in the design to install a third steam-turbine generator when required by future expansion.

If and when fuel costs and load conditions justify, a second hydro unit can be installed to utilize water in Mill Creek for part of the year.

A 2500-kva, 150-psig condensing turbine-generator was moved from the old power plant and reinstalled in the new building to be used as a stand-by unit.

Operation of the Woodfibre power plant requires astute judgement to apportion the load to the various units throughout the year to generate power requirements at minimum cost. A power usage diagram, shown herewith, was designed to assist in evaluating load requirements.

The hydro unit, a slow-speed, high-head Pelton wheel, is essentially a base-load generator. Instantaneous peaks, therefore, must be carried by the more sensitive steam-turbine-driven generators.

The woodroom load curve, from the recording wattmeter chart (not shown), indicates load variations of as much as 1000 to 1500 kw instantaneously when logs up to 40 in. diameter are fed to the 1200-hp chipper.

To improve governor operation and generate maximum power, under conditions of minimum process steam requirements, the governors are designed so that the turbines satisfy the mill's demand for 50-psig steam before any steam is extracted from the turbine.

Pressure-reducing stations between the 550 and 150, and between the 150 and 50-psig steam mains maintain pressure fluctuations in line with the frequency change as controlled by the steam turbine governors.

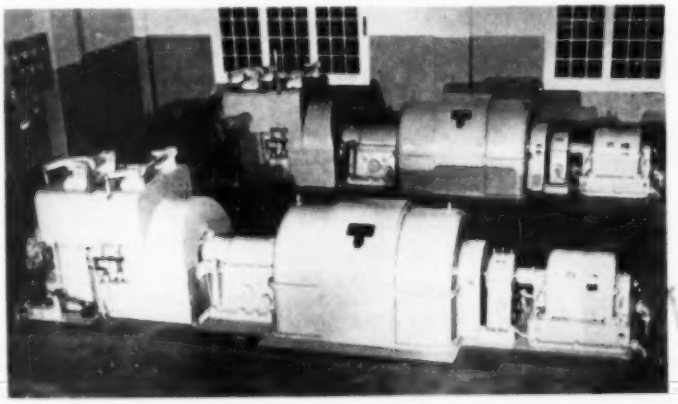
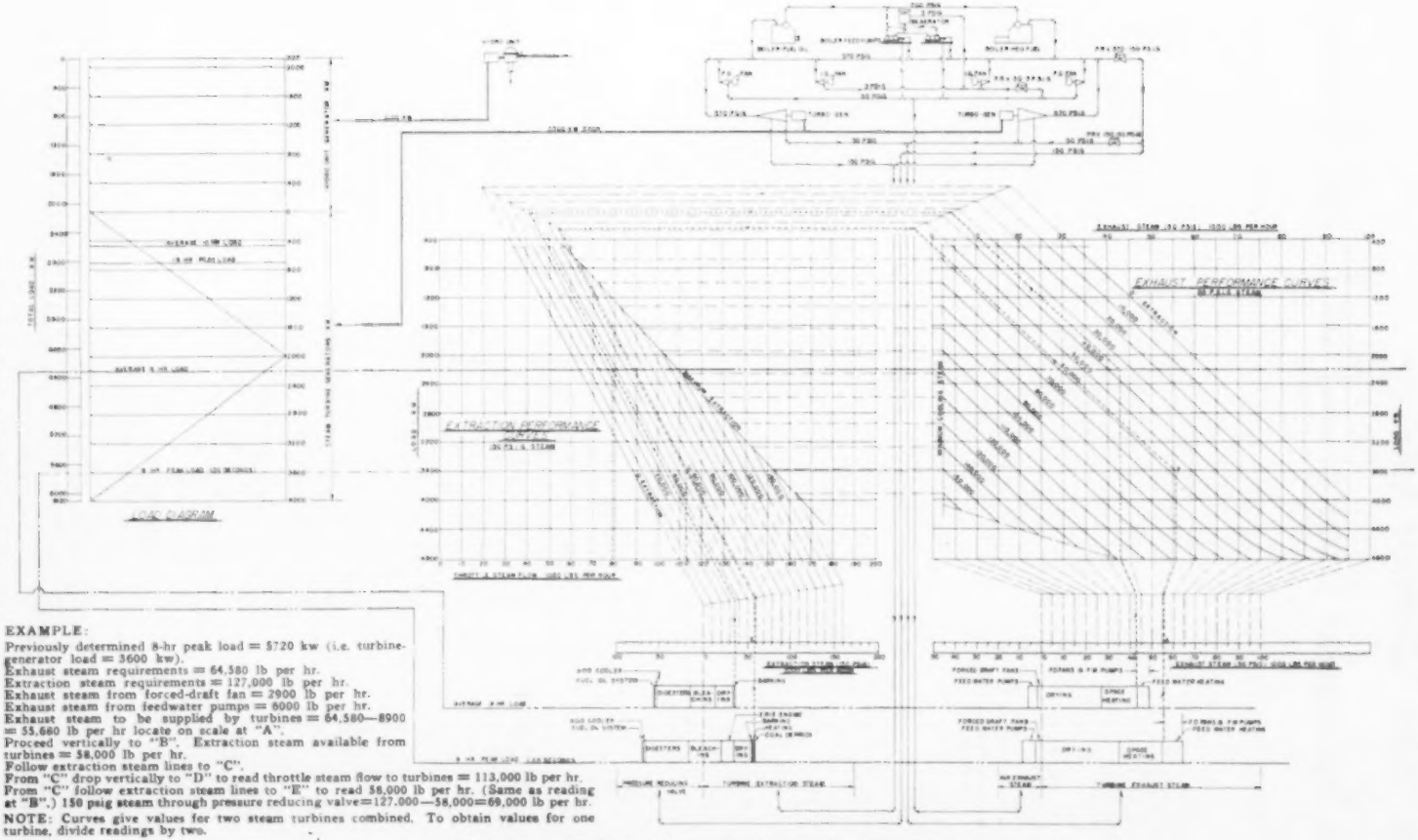


Fig. 1. View of the two new Elliott 2000-kw, 550-psig, 725-F steam turbine generators at the Woodfibre mill. These supply 150-psi extraction steam and 50-psi exhaust steam



EXAMPLE:

Previously determined 8-hr peak load = 5720 kw (i.e. turbine-generator load = 3600 kw).
Exhaust steam requirements = 64,580 lb per hr.
Extraction steam requirements = 127,000 lb per hr.
Exhaust steam from forced-draft fan = 2900 lb per hr.
Exhaust steam from feedwater pumps = 6000 lb per hr.
Exhaust steam to be supplied by turbines = 64,580—8900 = 55,680 lb per hr locate on scale at "A".
Proceed vertically to "B". Extraction steam available from turbines = 58,000 lb per hr.
Follow extraction steam lines to "C".
From "C" drop vertically to "D" to read throttle steam flow to turbines = 113,000 lb per hr.
From "C" follow extraction steam lines to "E" to read 58,000 lb per hr. (Same as reading at "B".) 150 psig steam through pressure reducing valve=127,000—58,000=69,000 lb per hr.

NOTE: Curves give values for two steam turbines combined. To obtain values for one turbine, divide readings by two.

Fig. 2. Power usage diagram for new power plant at Woodfibre mill aids in dividing load between steam and hydro units for minimum power cost

Can "The Glamor Girl"— The Spreader Stoker—Fire Large Boilers?

By J. S. **BENNETT**, Vice President, and F. C. **MESSAROS**, Chief Engineer, American Engineering Co.

THE HISTORY of building bigger boiler units is largely the story of the fight to burn more coal per foot of furnace width. Here are some suggestions on how to burn as much as 2500 lb coal per hr per foot of furnace width on spreader stokers and thus serve boilers as large as 500,000 lb per hr steam capacity, all within the limits of established stoker practice. But first—

FOR READERS of this article, the authors "would like to invoke the spirit of Alex Dow, who did so much to promote the development of large boiler units. Mr. Dow was never willing to accept routine engineering. He was a tough taskmaster, who had vision. The spreader stoker has been described as 'The Glamor Girl' of the combustion field. But glamor alone won't give us large stoker-fired boilers. It will take engineers who will refuse to be satisfied with boilers and furnaces outmoded for stoker firing, but who, like Alex Dow, will insist upon getting what they should have. Public utility engineers have sparked many developments in the past. It would seem that they have another job ahead."

What Multiple-Retort Underfeed Stokers Did

Until the late 1920's, the multiple-retort underfeed stoker was the predominant method of coal firing. One of the major steps in increasing boiler capacity utilizing stokers was carried out under the direction of the late Alex Dow of The Detroit Edison Company at the Delray plant of that company. This was covered in a paper by Dr. D. S. Jacobus before the 1911 annual meeting of the ASME. Various developments in the plants of that company resulted, by 1920, in underfeed stokers capable of burning coal at rates as high as 950 lb per foot of furnace width. See Fig. 1.

Total capacity of stoker fired boilers gradually increased during the 1920's as in Fig. 1, aided by the parallel development of furnace water cooling.

During the depression, stoker designs settled down and the tendency to "over-reach" was largely eliminated. Today the underfeed stoker is recognized as a superior method for obtaining freedom from stack nuisance, and giving high net efficiency, especially over a very wide load range. Few engineers today would fail to consider stokers for boilers with capacities below 200,000 lb per hr, but stoker-fired boilers of 300,000 lb per hr are rare.

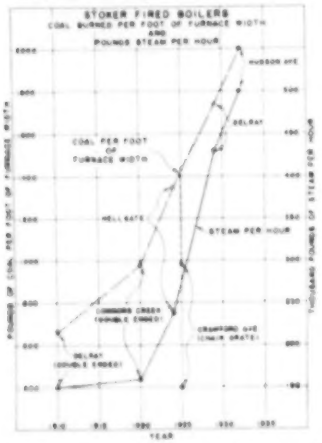


Fig. 1. Chart showing development of stokers capable of burning increasing quantities of coal per foot of furnace width. Unless otherwise noted, performance was obtained with underfeed stokers

Pulverized Coal Led to Big Boilers

In the middle 1920's, pulverized coal firing permitted a sharp increase in the amount of coal burned per foot of furnace width and made possible the successful operation of boilers with capacities of over 1,000,000 lb of steam per hour. Most engineers will, in the future, be more interested in generating 500,000 lb of steam per hour or less per boiler.

Pulverized coal did permit burning of low-fusing-ash coals, but hopes that pulverized coal would make it practical to burn a wide range of coals were not fully realized, and many installations designed for relatively poor coals had to return to premium coals. Fly ash discharge, boiler slagging, consumption of auxiliary power, are still pulverized coal problems. The authors reviewed those developments in detail, in a paper before the 1949 meeting of the ASME at New London, then presented the following data on the spreader stoker.

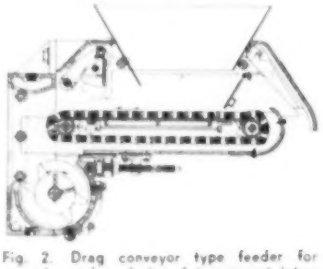


Fig. 2. Drag conveyor type feeder for spreader stoker, designed to prevent interruption to flow of wet coal. Feeder 12 in. wide designed to feed 7500 lb coal per hr, and to permit using fewer feeders on boiler front, thus giving increased space for ease of servicing

Rise of the Spreader Stoker

The spreader stoker is very old, but its large-scale commercial use did not begin until about 1930 when its low first cost, ability to burn poor coals, and freedom from operating troubles led to its wide adoption. Better application engineering and the utilization of cinder return and overfire air devices increased its popularity. Introduction of the continuous ash discharge type of grate increased spreader stoker capacities rapidly, and many continuous ash discharge spreader installations generating from 30,000 to over 200,000 lb of steam per hour have been made.

Continuous ash discharge spreader stokers give excellent efficiencies with a very wide range of coals, and astonishing freedom from clinker problems. Combustible in the ash is reduced almost to the vanishing point. Since so large a proportion of the coal is burned in suspension, a substantial amount of solid material is entrained with the gases and leaves the furnace. A large percentage of these solids is coarse and drops out in soot hoppers under the boiler, economizer and preheater; most of the remainder is still coarse enough to be trapped in a comparatively inexpensive cinder collector. This solid material contains a substantial amount of unburned carbon and the usual practice is to return it to the furnace for reburning as a convenient means of disposal and to avoid a loss in efficiency. All ash from spreader stokers can be removed from the ash hopper. There need be no fly ash disposal problem with spreader stokers.

Importance of overfire air in reducing carryover has been fairly well established but the benefits derived from its use are largely dependent upon the proper application and design of the nozzle equipment.

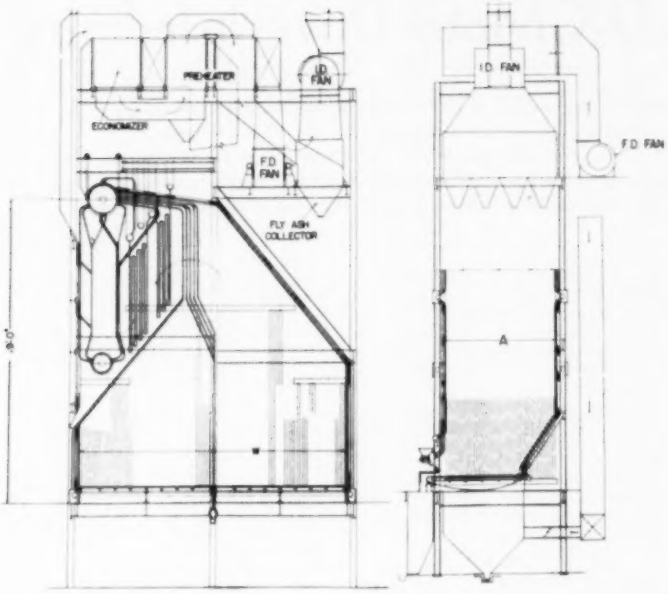


Fig. 3. (Left)—Cross-firing of large boilers by spreader stokers, like this, would permit units to be constructed of 300 000 to 500,000 lb per hr steam capacity. Two independent stoker units separated by water screen would have burning rate of 2500 lb coal per foot of furnace width. Boiler is of same general type as installed in a large number of plants. Design would minimize boiler slagging, permit operating only one stoker for low loads with best combustion, good smoke control and superheat control

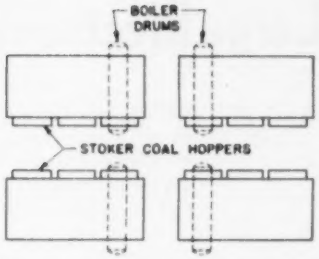


Fig. 4. (Above)—If boilers were cross-fired by spreader stokers, new boiler arrangements for several boilers, with units placed end to end, might be necessary; but coal bunker arrangement would be conventional

We Must Not "Blow Up" Spreaders Too Much

Spreader stokers today with capacities of from 150,000 to 200,000 lb of steam per hour operate well; but we must be careful that we do not continue to "blow up" small stokers into big ones. Even at present, many units have an excessive number of feeders jammed up so close to each other that there is scarcely room to get between them. Mechanisms are multiplied and adjustments and service become burdensome. Higher coal feeding rates mean more attention must be given to avoiding possible interruptions to coal feed caused by wet coal.

Large boiler units generally involve high pressure and high steam temperature, making the use of preheated air a "must." Little is known, so far, of the effect of preheated air on spreader stoker firing. Exaggerated claims as to safe preheat temperatures should be examined critically.

Details to Be Considered for Increasing Capacity

Smoke, which is apt to occur at low rates with spreader stoker firing, must be given special attention on large units. The tendency to undersize units so as to increase the burning rate at the low rating is not the answer in all cases and can result in serious difficulties at top steaming rates.

Increase in the feeding capacity of the individual feeder unit has been found practical by utilizing a drag conveyor construction in the feeder, Fig. 2, to prevent interruption to the flow of even wet coal into the furnace. A feeder only 12 in. wide and of this construction will feed 7500 lb of coal per hour.

Effective utilization of the high pressure air used for returning cinders may be obtained by using venturi fittings as shown in Fig. 5. A separate line to the furnace from each cinder drain point should be used. Grouping these drain points leads to unreliable return of cinder.

Overfire air should be adjusted at each nozzle to suit the conditions existing on each job. See Fig. 7.

As previously shown, Fig. 1, single-ended multiple retort underfeed stokers approximately 27 ft long had been built and operated, which resulted in coal burning rates of 1350 lb per foot of width at burning rates of 50 lb per sq ft per hr. Double-ended units giving much higher burning rates were possible but were not generally acceptable because of the double coal bunker construction involved.

Restrictions on Spreader Burning Rates

The permissible burning rate per square foot on spreader stokers is largely a function of the pounds of air being supplied to each unit of area to produce combustion. Therefore much higher coal burning rates may be obtained with coals of low calorific value. The older "coal per

(Continued on page 90)

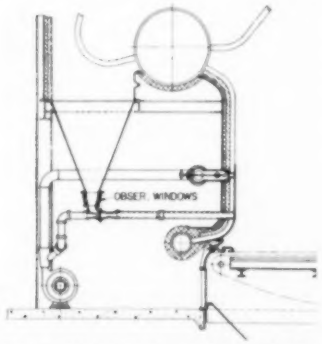


Fig. 5. Venturi fittings and separate line to furnace from each drain point promote effective use of air for cinder return systems on spreader stokers

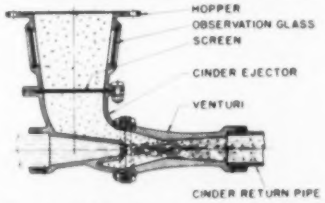


Fig. 6. Detail of one of venturi fittings shown in Fig. 5. This is an ejector, the venturi giving positive suction of cinders out of hopper

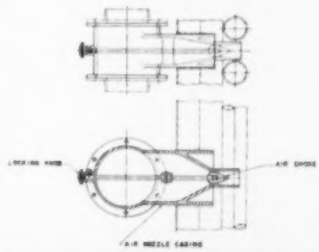


Fig. 7. Nozzle for supplying overfire air to spreader stoker is designed so it can be easily adjusted to conditions on each individual unit

Large Electronic D-C Motor Drives in Industry

Until recently the application of electronic controls for motor drives has been limited to rather small powers by the size of rectifying devices available. Now, however, rectifiers and circuits have been developed that permit the application of electronic d-c motor drives in sizes as large as 3500 hp. These new drives, therefore, offer excellent opportunities for improving plant performance and reducing over-all costs

FOR MANY YEARS, almost since the beginning of the electrical industry, electrical engineers have been searching for an efficient variable-speed alternating current motor; a motor with the variable-speed characteristics of the direct-current motor and the reliability and economy of the squirrel-cage alternating-current motor. The search led to the development of may types of controls, using resistors, auto-transformers, etc., but none of the schemes devised were entirely successful. The basic reason for this failure to develop a good variable-speed a-c motor, of course, lies in the fact that the a-c motor, with a given frequency, is essentially a constant-speed machine.

It was not until the development of suitable, reliable and large enough rectifiers, that the solution to the baffling problem became apparent. What was needed was simply a method whereby the alternating current could be rectified and under proper control delivered to *direct-current* motors. In other words, what was needed was a means for running direct-current motors from alternating current-circuits.

The first successful attempts in this direction was the use of thermionic rectifiers in the Thy-mo-trol and the Mot-O-trol systems, but these systems were applicable to relatively small drives—drives such as involved in the operation of small lathes, drill presses, etc. Both of these systems consisted of direct-current motors, supplied from a-c power sources through grid-controlled rectifiers together with necessary auxiliary equipment.

Present developments in power circuits and larger rectifying devices, however, have overcome previous difficulties with higher powered equipment so that now such rectifier-motor systems are being used in applications requiring many hundreds of horsepower.

New Drives Available

The extent to which such large rectifier type drives are being used in commercial service is indicated by a paper presented before the recent meeting of the American Institute of Electrical Engineers in New York by M. M. Morack of the Industrial Engineering Division of the General Electric Co. This paper dealt with the application of adjustable voltage rectifiers for driving d-c motors or groups of motors.

As pointed out in this paper, when a rectifier and a d-c motor are considered as a unit, a variety of speed torque characteristics may be obtained with the following features:

1. Wide, stepless speed range
2. Smooth acceleration by current limit control
3. Automatic speed regulation at present speeds
4. Rapid retardation by dynamic braking
5. High efficiency

The Thy-mo-trol and Mot-O-trol systems mentioned above made use of the thermionic type of grid-controlled rectifier. These newer larger systems on the other hand make use of the ignitron type of rectifier since these are capable of handling much larger currents. In a multiphase rectifier using tubes of this type, each ignitron carries current in sequence as its anode voltage becomes positive and the arc is allowed to extinguish at the end of each positive half cycle. Before an ignitron will conduct, it is necessary to establish a cathode spot or arc. One function of the excitation equipment is to provide the current impulses to the ignitors and thus start the arc in each ignitron at the proper instant and in sequence as required by the supply voltage. The excitation equipment also provides means of shifting the instant at which the impulses occur (known as phase control) and is a convenient means of adjusting or regulating the d-c output voltages from the d-c signal obtained from the regulating system. This is accomplished by means of a network including variable impedance reactors whose reactance is varied by d-c saturation of the magnetic core. In other words, when the saturating current is at a minimum, the rectifier voltage is low and vice versa. This relationship is identical with that of d-c generator field current and its output voltage.

The starting and acceleration of a d-c motor constitutes a problem when a rectifier is used as the power supply. When the motor is at standstill the armature current will be limited only by the rectifier voltage and the resistance and inductance of the armature. After the motor has started running, a cemf is generated in the armature winding which may be assumed to be in direct proportion to the speed of the motor. Current limit may be provided by the regulating system which does not permit the armature current to rise above a predetermined value.

A conventional shunt motor operating at constant voltage, has a slightly drooping speed-torque characteristic because of the effect of armature voltage drop which assum-

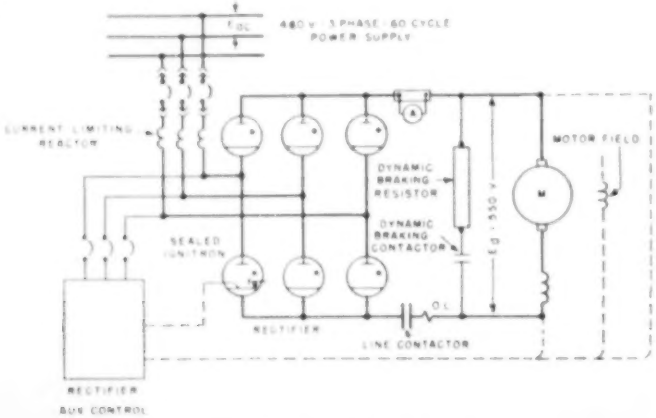


Fig. 1. Elementary diagram of an electric d-c motor drive

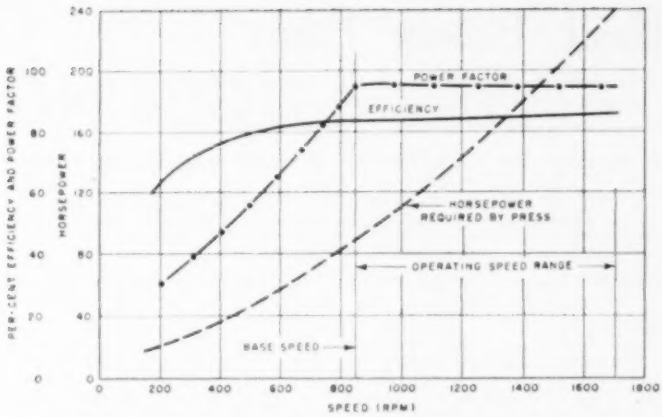


Fig. 2. Efficiency and power factor characteristics of adjustable speed drive using armature voltage control below base speed and field control above base speed

ing constant magnetic flux, is directly proportional to the torque. The variation in speed is greater at low speeds because at lower values of armature voltage the IR drop constitutes a higher percentage of the armature voltage. The speed regulation of a rectifier-motor system is a combination of the inherent regulation of the motor and the regulation of its power supply. In the case of the rectifier supply, regulation is only a few per cent over a load range except when the current becomes discontinuous. Under this condition the votlage regulation of the rectifier is relatively large and is reflected in the speed regulation of the motors. For low speed running the speed-torque characteristics of the drive can be improved if the angle of phase retard of the rectifier is automatically adjusted by the regulating system in accordance with the torque variation, i.e. advanced with increasing torque and delayed with decreasing torque so as to maintain constant speed independent of load.

Acceleration of the drive is accomplished by adjusting the output voltage of the rectifier from zero to 100 per cent by phase control. During acceleration full field is applied to the motor by a separate source. When the rectifier voltage is at a maximum, no additional speed can be obtained by armature voltage control. The motor field may now be weakened to attain maximum speed at full armature voltage.

In the circuit shown in Fig. 1, the unidirectional conductivity of the rectifying devices prevents reverse current from being fed back into the supply system. The speed of the drive motor can be lowered by strengthening the motor field or by reducing the armature voltage. When rapid deceleration is required, a contactor and a dynamic-braking resistor may be employed to absorb the regenerated energy.

For drives in the 100 to 600 hp range, using the double-way power circuit, the relationship between the a-c supply voltage and the rectifier d-c voltage permits the use of a 550 v motor when operating directly from a 460 v a-c supply, thus eliminating the economic disadvantage arising from the use of the associated anode transformer. When the supply voltage is higher than 575 v, a standard three-phase transformer may be used to supply 460 v to the double way rectifier. Although a transformer is now required, the double way circuit is still to be preferred because this type of power transformer is less expensive than the usual rectifier transformer which operates at a lower utility factor and has a complicated secondary winding configuration.

Motor Performance

Another advantage inherent in the double way power circuit is that the output wave form is that of a controlled six-phase rectifier which allows the use of 550 v motors approximating conventional design. A d-c motor operating on rectified power may be expected to show greater than normal temperature rise because of greater losses resulting from the effects of ripple in the armature current. The losses in the current carrying parts are increased by additional eddy current losses resulting from the increase in effective resistance caused by skin effect and by reason of the fact that the RMS ratio to average current is greater than unity. The armature and field core material will show increased eddy currents and hysteresis loss because of the resulting flux pulsation. Test results (3) and the field experience, however, show that no derating might be required if extended operation at reduced voltage were contemplated.

The commutating performance of a d-c machine operating from a rectifier supply might also be expected to be adversely affected when the frequency of the ripple is so high that the commutating pole flux no longer compensates for armature reaction and sparking may result. Here again a comparison of black band commutating tests and field experience shows that there is no discernible decrease in commutating ability of the d-c machine when a six-phase power supply is used. Even at reduced voltage the machine performs practically as well as with a d-c generator supply.

Efficiency

The combination of a rectifier and 550 v d-c motors gives the electronic d-c motor drive the advantage of high efficiency over a wide speed range. Fig. 2 shows the calculated over-all efficiencies of the drive for a given speed-horsepower characteristic. In contrast with some adjustable speed drives, the efficiency of the electronic drive falls off gradually with decreasing speed. The

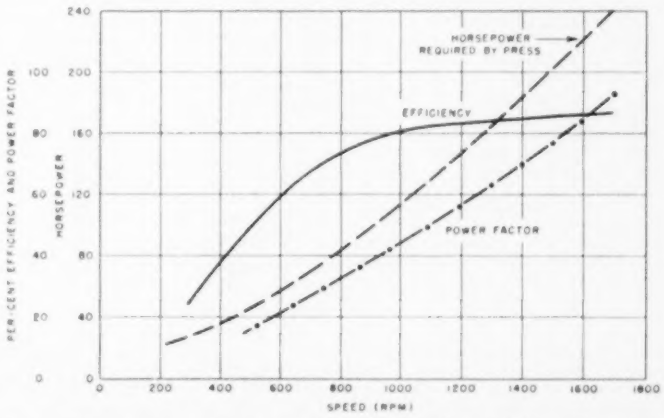


Fig. 3. Efficiency and power factor characteristics of adjustable speed drive with armature voltage control at full field

lower efficiency at reduced speed results from the fact that the major rectifier loss is caused by arc drop voltage of the rectifying devices which is approximately independent of current. When the d-c voltage is reduced by phase retard, the arc drop loss represents an increasing proportion of the total power.

Power Factor

Remember that as the armature voltage is reduced by phase control, the power factor on the a-c system is reduced in about the same proportion. In the upper part of the speed range where the power required is large, some speed control by field weakening is desirable because it will result in a better over-all power factor and efficiency. This fact is illustrated by comparing the power-factor characteristics of Fig. 2 with Fig. 3.

When operating under a constant field excitation, the d-c motor supplied from a variable voltage source represents a constant torque drive and utilizes to the fullest extent its armature volume throughout the speed range. An adjustable speed d-c motor having speed variation by shunt field control represents a constant horsepower drive. Comparing a constant torque and a constant horsepower machine having the same rating at maximum speed, the constant horsepower motor will be the larger because of the necessity of providing higher torque at base speed. By combining motor field control with rectifier phase control it is usually possible to obtain a drive with the required speed range, while maintaining good efficiency and power factor consistent with first cost.

Application

At the present time, applications of electronic motor drives are being made in ratings of 100 to 18,500 hp preferably with 550 v motors where reversing is not required. More than a score of applications have been made including drives for printing presses, fans, and metal working mills using rectifiers in ratings up to 400 kw output.

Large pumped ignitron rectifiers are also finding application in adjustable voltage systems for main motor drives in steel mills requiring rectifiers rated up to 3500 kw at 600 v.

It may be concluded that suitable rectifying devices and power circuits have now been developed which permit a new approach to the problem of adjustable speed and motor drives for industry. The new electronic tools are giving an ease of control, a higher efficiency, and an ease of maintenance unmatched by older forms of adjustable drive equipment. The electronic drive equipments, because of their infancy, will offer the best chance of over-all cost reduction.

Basic Power Plant FIGURING

A Review for Old-Timers — A Must for Young-Timers

By **WILLIAM H. ENGELMAN**, Mechanical Engineer
Department of Water & Light, City of Cleveland, Ohio

All re-publication rights reserved by author.

How to Calculate Pipe Size, Pressure Loss, Flow and Velocity for Flow of Steam Based on Unwin's Formula

SEVERAL METHODS of calculating flow of steam in pipes, taking into account all the various factors involved, and of determining friction losses and pressure drop in steam piping are discussed in the Piping Handbook, by Sabin Crocker, Fourth Edition (McGraw-Hill Book Co., Inc.). These are contrasted and compared; data are also given on how to select proper piping for various conditions.

Every power engineer should be familiar with the different methods of steam flow calculation. However, in solving practical problems, it is not common to go through all these calculations, which take much time. Instead, many of the formulas can be shown graphically and these graphs can be used for quick answers accurate enough for most practical work.

One of the important factors involved in steam flow calculations is pressure drop in piping for a given flow, length and size of pipe. Methods of calculating pressure drop have been worked out in formulas by Babcock, Carpenter, Unwin and Fritzche. The first three are practically identical and Unwin's formula can be expressed in units common to practical engineering work, hence it is frequently used in practice. The various factors in the formula are charted on the opposite page.

It may be interesting to compare results from this chart with those obtained from the Pipe Sizing Tables by A. B. Stickney, (based on the Moody formula) POWER GENERATION, July 1949.

Here are some of the practical problems that can be solved by use of the Unwin chart. You may also need to refer to Pipe Tables A and B, August 1949 issue and to Keenan & Keyes Steam Tables.

1. Example on chart: A 12-in. Sched. 40 pipe delivers 2,000 lb steam per min at 225 psia and 200 F superheat. Find pressure drop and velocity.
Follow 225-lb guide line to 200-deg superheat line; then vertically down to 2,000 lb per min line, then diagonally to 12 in. 40 pipe diameter, then vertically to pressure drop scale. Ans.—0.85 lb. per 100 ft.

Volume is 2.68 cu ft per lb
Pipe area is 0.7773 sq ft
Flow is 2,000 lb per min

$$\text{Velocity is } \frac{2{,}000 \times 2.68}{0.7773} \text{ or } 6{,}900 \text{ fpm}$$

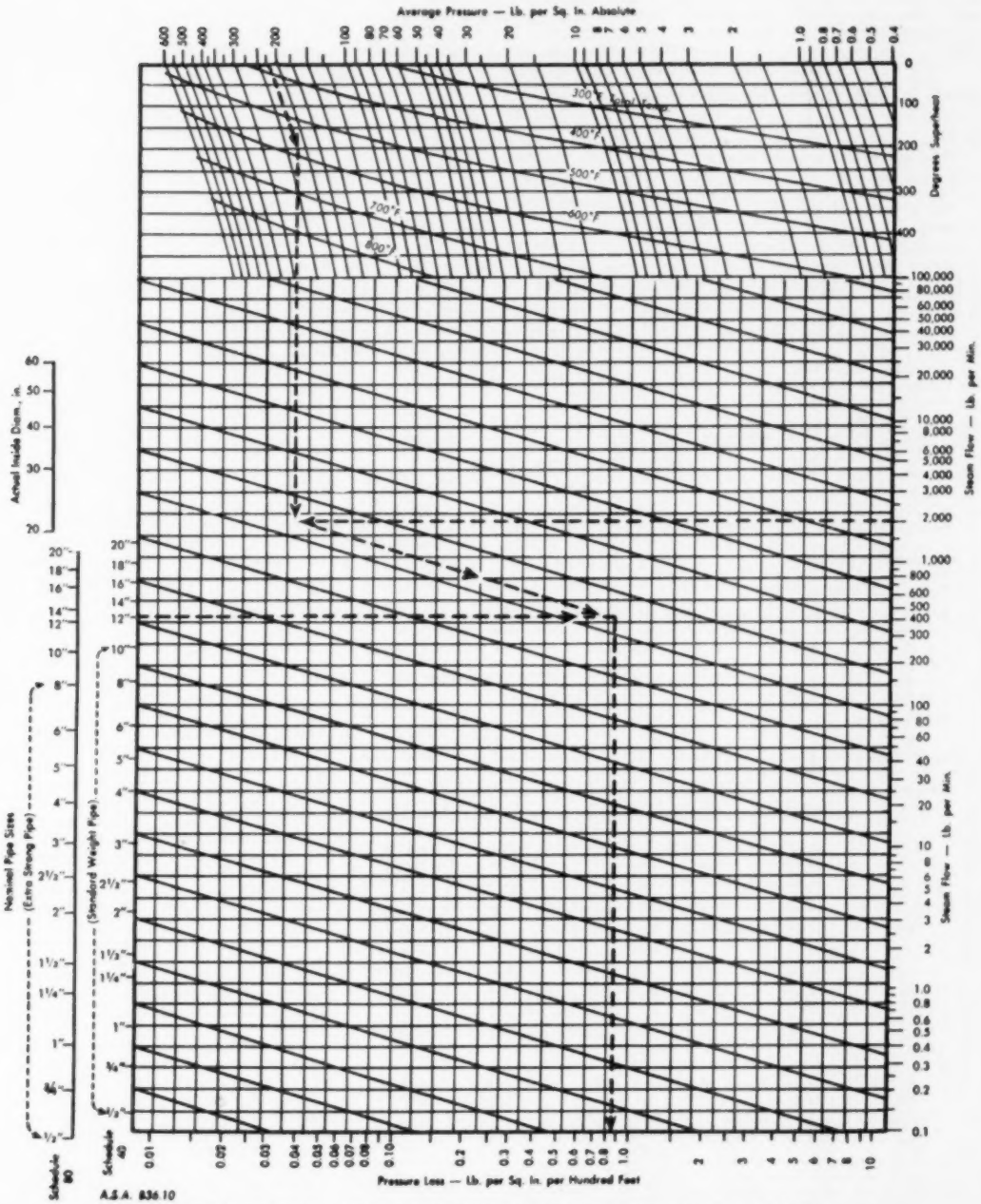
(Continued on page 90)

Table I. Flow of Steam in pipes in cubic feet per minute

Sched. 40 Pipe	Area sq ft	Velocity of Steam in Feet per Minute							
		3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
1	0.0060	18.0	24.0	30.0	36.0	42.0			
1¼	0.0104	31.2	41.6	52.0	62.4	72.8			
1½	0.0141	42.4	56.6	70.7	85.0	99.0	113		
2	0.0233	70.0	93.0	117	140	163	186	210	
2½	0.0333	100	133	166	200	233	266	300	333
3	0.0513	154	205	256	308	360	410	462	513
3½	0.0687	206	275	344	412	481	550	618	687
4	0.0884	265	354	442	530	619	707	796	884
5	0.1390	417	556	695	834	973	1,112	1,251	1,390
6	0.2006	602	802	1,003	1,204	1,404	1,605	1,805	2,006
8	0.3474	1,042	1,390	1,737	2,084	2,432	2,780	3,127	3,474
10	0.5476	1,642	2,190	2,738	3,285	3,833	4,380	4,928	5,475
12	0.7773	2,332	3,110	3,886	4,664	5,441	6,218	6,996	7,773
14	0.9397	2,819	3,759	4,700	5,640	6,580	7,520	8,460	9,397
16	1.2272	3,682	4,909	6,136	7,363	8,590	9,818	11,045	12,272
18	1.5533	4,660	6,213	7,766	9,320	10,872	12,425	14,000	15,533
20	1.9306	5,792	7,722	9,653	11,584	13,514	15,445	17,375	19,306

Chart of Pressure Drop in Steam Pipes—by Unwin's Formula

This chart is adapted from a chart shown on page 255, Catalog No. 211, Tube Turns, Inc. Reproduced by permission from the Piping Handbook by Sabin Crocker, Fourth Edition. Problem 1 on opposite page gives instructions for using chart



A.S.A. B36.10

Reproduced by permission from the Piping Handbook, by Walker and Crocker (Copyright McGraw-Hill Book Co., Inc.)

SPREADER STOKER

(Continued from page 85)

square foot per hour" basis rather than the "Btu per square foot per hour" is used in the following discussion, on the assumption that this coal will give an evaporation of 10 lb of steam per pound of coal. A lower Btu coal will of course permit a higher burning rate per square foot.

Spreader stokers today have been established with lengths of approximately 18 ft. A conservative burning rate for spreader stokers of 50 lb per sq ft per hr would give a coal burning rate of 900 lb per ft of furnace width per hr, with a stoker 18 ft long. This 900 lb per ft of furnace width is, of course, much below figures for underfeed stokers 20 years ago, Fig. 1. Maximum length of spreader stokers is still to be determined; but, for the present, let us limit ourselves to what has been proved.

On this basis, a coal burning rate of 50,000 lb per hr or 500,000 lb of steam per hour would require a furnace 50,000 ÷ 900 = approximately 56 ft wide, which of course would be uneconomical with present-day boiler constructions. Thus the current limitations in size of the spreader stoker are the 18-ft length in one direction and the boiler drum length in the other.

Let's Try Cross-Firing with Spreaders

What can we do to eliminate these restrictions? A wide furnace is not the answer; but increased furnace length poses an opportunity. We can fire at right angles to the conventional direction, or **across** the furnace.

Such cross-firing might not be acceptable with either chain grate or underfeed stokers, because gas composition varies so widely from the front to the rear of the stoker; but a much greater degree of uniformity exists with spreader firing. For practical application see Figs. 3 and 4.

Boiler design was worked out in co-operation with Foster Wheeler Corp. and shows a general type which they have installed in many prominent utilities. Units of this type can be constructed for capacities of from 300,000 to 500,000 lb per hr. Two independent stoker units are separated by a water screen, permitting free passage of gas from one furnace to another and providing increased radiant heat absorbing surface.

Thus, without exceeding demonstrated stoker practice, a burning rate of over 2500 lb of coal per hour per foot of furnace width becomes entirely practical. With this method, stoker-fired boiler units of 500,000 lb per hr, with conservative burning rates, become practical. This furnace construction not only provides a means for minimizing boiler slagging, but offers effective use of heat absorbing surface in the steam generating unit. Lower steaming rates can be obtained by shutting one stoker down completely, thereby maintaining best combustion conditions and affording simple superheat control. The double furnace construction offers an opportunity to carry lower loads on one stoker only and by avoiding a low coal burning rate, makes smoke control simple.

In considering constructions of this kind, our old conception of boiler arrangements must be scrapped and we must use boilers placed end to end, Fig. 4, instead of side by side. This should introduce no real problem. Coal bunker arrangement is conventional and presents no special problem.

C. A. Sparks, chief engineer and director of the British Babcock &

BASIC POWER PLANT FIGURING

(Continued from page 88)

2. In Example 1, the steam flow has been changed to 1,000 lb per min. What will be the pressure drop? Ans.—0.20 lb per 100 ft.

   Flow is 1,000 lb per min
   Volume is 2.68 cu ft per lb. Velocity is $\frac{1.000 \times 2.68}{0.7773}$ or 3,450 fpm
   Pipe area is 0.7773 sq ft

3. With a given pressure drop of 6 lb in 100 ft, how many pounds of steam at 225 psia and 150 deg superheat will flow through a 12-in. Sched. 80 pipe? Ans.—4,800 lb per min.

   Flow is 4,800 lb per min
   Volume is 2.532 cu ft per lb Velocity is $\frac{4.800 \times 2.532}{0.7058}$ or 17,200 fpm
   Pipe area is 0.7058 sq ft

4. A 10-in. Sched 40 pipe, 100 ft long, carries steam at 145 psig and 514 F TT. With a pressure drop of 10 lb how many pounds of steam will it deliver? Ans.—3,500 lb per min.

   Flow is 3,500 lb per min
   Volume is 3.50 cu ft per lb. Velocity is $\frac{3.500 \times 3.50}{0.5476}$ or 22,370 fpm
   Pipe area is 0.5476 sq ft

5. If the pipe in problem 4 is 500 ft long and the pressure drop 7.5 lb, how many pounds of steam will it deliver? (Drop is 1.5 lb per 100 ft.) Ans.—1,600 lb per min.

   Flow is 1,600 lb per min
   Volume is 3.50 cu ft per lb Velocity is $\frac{1.600 \times 3.50}{0.5476}$ or 10,220 fpm
   Pipe area is 0.5476 sq ft

6. A building requires 12,000 lb of steam per hour at 40 psia. The pipe is 200 ft long. Find size of pipe required with 2 lb pressure drop. 12,000 ÷ 60 is 200 lb per min. Ans.—6-in. Sched. 40 pipe.

   Flow is 200 lb per min
   Volume is 10.5 cu ft per lb Velocity is $\frac{200 \times 10.5}{0.2006}$ or 10,470 fpm
   Pipe area is 0.2006 sq ft

7. A 3000-kw turbine-generator with a steam rate of 14 lb per kw hr operates at 450 psia and 750 F TT. The pipe is 100 ft long and the allowable pressure drop 3 lb. Find size of pipe. Ans.—6 in., Sched. 80 pipe.

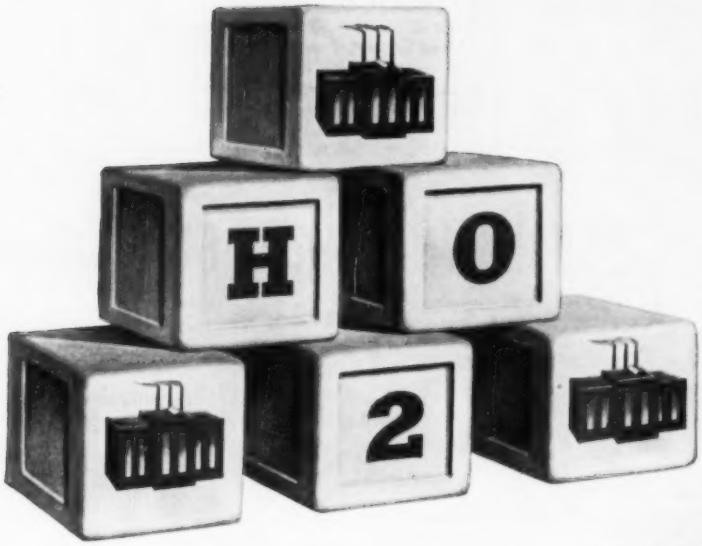
   Flow is 700 lb per min
   Volume is 1.534 cu ft per lb Velocity is $\frac{700 \times 1.534}{0.1810}$ or 5,930 fpm
   Pipe area is 0.1810 sq ft

   Where pressure drop is excessive, use average of initial and final pressure.

Table II. Gage pressure, volume of steam in cubic feet per pound and reciprocal of volume

Pressure psig	Volume cu ft/lb.	Reciprocal 1/volume	Pressure psig	Volume cu ft/lb.	Reciprocal 1/volume
0	26.80	0.03731	100	3.88	0.2577
2	23.40	0.04273	110	3.59	0.2785
4	21.10	0.04739	120	3.33	0.3003
6	19.20	0.05208	130	3.11	0.3215
8	17.63	0.05672	140	2.92	0.3423
10	16.30	0.06135	150	2.75	0.3634
15	13.75	0.07273	160	2.60	0.3847
20	11.90	0.08403	170	2.47	0.4055
25	10.50	0.09524	180	2.34	0.4266
30	9.40	0.10640	190	2.24	0.4474
40	7.80	0.1282	200	2.13	0.4686
50	6.70	0.1493	225	1.920	0.5214
60	5.82	0.1718	250	1.742	0.5741
70	5.20	0.1923	275	1.595	0.6270
80	4.65	0.2151	300	1.470	0.6803
90	4.25	0.2353	350	1.267	0.7893

How many pounds of steam per minute will an 8 in. pipe deliver at 30 psig and a velocity of 8,000 feet per minute? Answer:—2,780 (from Table I) × 0.1064 (from Table II) = 295.8 lb per min.
For higher velocities add values in table; thus, 14,000 = 2 × 7,000.



HOW TO BUILD PROFITS!

WATER, which is a basic requirement of industry, is seldom suitable for use in its natural state. Adequate protection from the many hazards which accompany the use of incorrectly or inadequately conditioned water, whether for boiler, cooling or process use, is one positive way to increase plant efficiency . . . *and build profits!*

For over two decades BETZ has provided engineering guidance and developed control procedures for the correction and prevention of all water difficulties. If the results you are presently obtaining are not fully satisfactory, our nationwide staff of engineers welcomes the opportunity to discuss your water problems. Why not start building profits *today?* W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pennsylvania. In Canada: BETZ Laboratories Limited, Montreal 1.

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

Wilcox Ltd., in a recent paper on steam generation in the U. S., before the Institution of Electrical Engineers in London, said:

"The author foresees that the pulverized-coal-fired boiler will suffer in availability as fuel conditions deteriorate. Nevertheless, it seems probable that this method of firing must continue to maintain its place of importance, particularly for the disposal of all coals too fine for burning in a crushed, as opposed to a pulverized, state. Because the methods of crushed-coal firing so far developed are not so sensitive to ash quality and quantity, and because a high percentage of all these residues are discharged direct to the ash pit, it seems that pulverized coal may be gradually displaced where fuel suitable for cyclone or spreader firing is available. The author considers that overfeed-fired furnaces can already meet power station requirements for moderate capacities between the limits of 75 and 150 tons evaporation per hour, and that experience may lead to even larger output from boilers so equipped, whilst cyclone-furnace-fired boiler units may overlap and eventually take care of any larger capacities which may be required."

The Honor of Dignified Willy

Oscar, the Gas Works Owl, has a low opinion of engineers in their display of tact. This case of Dignified Willy's one-man sit-down strike called for a lot of tact which was supplied in ample quantity when the President of the Company appeared on the scene

By JOHN RAVEN

ONE MORNING I was all upset because this was the day the Chief in Boiler House No. 2 was going to quit if I didn't get him a 10 cent raise. Well, I didn't get it, and since the Boss promised to demote me if the Chief quit, I figured I was as good as cleaning flues right now.

At this low moment I saw the overturned India ink bottle and the note from Oscar, and those familiar hen-tracks had never looked sweeter. He never lets me down, I thought, and grabbed up the note.

if u njuneers showd mor respect 4 urselves (I read) n used mor tact here n there u wud get along bettr now u go c that guy hoo calls himself dignified willy n get a lesson on how 2 hold ur job also the last mice u put out wer a littl puny ur frend oscar th gas wrks owl hoo sees al n nos al

Sadly I tore up the note and threw it into the waste basket. This Dignified Willy is a night stillman that comes to work wearing big waxed mustaches and a high silk hat, and is so uppity even his own kids address him as "your honor." All Willy could show anybody was how to be a screwball, so I just put on my hat and went into the Boss' office to make my last plea and then get demoted.

"Raise!" bellowed the Boss, banging his telephone up and down. "Haven't I got enough trouble with the President just phoning that he's coming to inspect the works, and with that idiot Dignified Willy staging a one-man sitdown strike because the night superintendent fired him for sleeping on the job? D'you want the President to nail me to a gas holder for his labor relations department to shoot at?"

He bounced out of his chair like Old Faithful at full pressure, and shook his three red chins under my nose.

"Right now," he made my ear drums rattle, "your number 1 job is to get rid of Dignified Willy before the President sees him. You hear? Get rid of him at once. Then maybe we'll talk raises. Maybe, I said. Now get out. I want action."

"Yes sir," I said tactfully, thinking I was lucky he hadn't promised to fire me in case of trouble with Willy. He is a little hasty at times.

I found Dignified Willy sitting outside of the toluol house on a steel barrel, with his arms crossed on his mighty chest, and staring over the heads of a half dozen curious works people in a kind of austere majesty.

Dignified Willy sitting on a steel barrel with his arms crossed on his mighty chest

Under his high silk hat, and with his waxed mustaches projecting like black spears on each side of his big jowls, he looked so much like a heathen king surrounded by his subjects, that I almost bowed before speaking.

"Your honor," I said tactfully, "since you were fired several hours ago, I've been ordered to get you off the premises. I trust you're prepared to leave at once? And peaceably?"

Before replying he produced a knife big enough to clean fish with, waved it significantly in the sunlight, and then cut himself a chunk of tobacco and stoked his mouth.

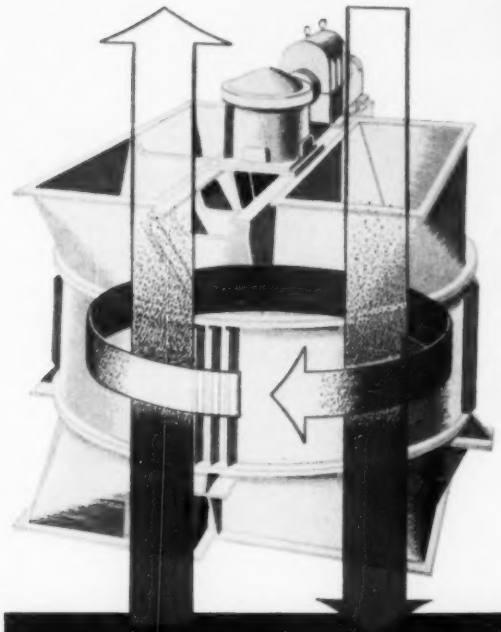
"My compliments to the Great Bushwah that sent you, John," he rumbled through his waxed mustaches, "but I ain't been fired by nobody. Not for sleepin' on the job I ain't. That's a insult to my honor. I demand a apology. Tell him I'm a-sittin' on this here barrel 'till I git a apology if it takes 'til hell freezes over."

A stir of admiration passed over the crowd while my face got red at being thus appointed a messenger boy between himself and the Boss. I decided to try another approach.

"Dignified Willy," I said reasonably, "you know you cant' stay on that barrel for long. What'll you eat? What'll you do when it rains? Who'll take care of your family? Why don't you go home right now and save all that trouble?"

He squirted a Niagara of tobacco juice over his left shoulder with kingly confidence.

"My kids are bringin' me vittles, a umbrella and house slippers. And if I git sick with p-newmonia or such, I'll sue the gas works. Right



this preheater is cutting fuel costs in hundreds of plants

the *Ljungstrom* AIR PREHEATER

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

The Ljungstrom air preheater has proved its value in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

Your fuel costs will be lower too, when your boiler is equipped with the Ljungstrom air preheater. The regenerative design of the Ljungstrom permits reliable operation at low exit gas temperatures. This assures the greatest possible heat recovery . . . reduces the amount of fuel required.

If you are planning a new installation, or expanding your present one, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the overall efficiency of *your* plant.

THE AIR PREHEATER
60 East 42nd Street, New York 17, N. Y.
CORPORATION

quick too, considerin' the insult to my honor."

A day shift man came out of the toluol house and said I had a phone call. I expected the worst and it was.

"John?" the familiar bellow knocked my ear drums back two inches. "You get rid of Willy? The President's at the gate."

"Not quite," I said trying to be tactful. "And if he gets sick he's going to sue the works. Shall I call the cops?"

"The cops! Sue the works!" the phone all but jumped out of my hand. "Great heavens! How'd you mess things up like that? John, you go meet the President and take him to the gas house, or a boiler house, or anywhere but here. I'll get rid of Willy myself. And if you mess up the President the way you messed up this, consider yourself fired!"

The phone banged, and I started for the gate house. On the way I passed a grimy procession of pigtails and bare feet, ages four to eleven, lugging a coffee pot, an umbrella, and other assorted comforts for Dignified Willy. I shuddered at the explosion when the Boss met that crew.

The President was sitting in his limousine, talking to the gate watchman. They had started in the gas works on the same day, forty years ago.

The President had eyes as quiet and gentle as gimlets.

"Where's your Boss, John? Settling that sit-down strike at the toluol house? Get in, we'll join him."

I looked a little bewildered at the watchman, and the President saw the look and said:

"When I saw those kids, I asked questions. It may take a little tact to handle this case, and that's something you engineers don't have too much of."

I didn't have too much of a job, either, I thought, as we drove in state, chauffer and everything, to the toluol house. In fact only my natural politeness kept me from telling the President good-by and good luck right there.

As we got out of the car, we could see the back of the Boss' red neck and hear him bellowing like an overstuffed bull of the woods.

"That," murmurred the President, "is what you call tact applied by sledge hammer."

He eased his way through the crowd and touched the Boss on the shoulder.

"Supposing you let me handle this."

The Boss turned around, and when he saw the President he was so mad he couldn't speak. The President then went up to Dignified Willy, who was now being shielded from the sun's rays by the opened umbrella, held over him by one of the kids, and looking more like a heathen king than ever.

"Mr. Dignified Willy," asked the President, "do you know who I am?"

"Sure." The high silk hat and waxed mustaches bobbed slightly. "You're the Charman of the Board which started in the coal gas house forty years ago."

"Not the Chairman, only the President," smiled the gimlet eyes, but I could see he was pleased. "I've been looking into your case, and I realize that men of position like you and me, are never fired, we quit. Isn't that right?"

"Right," agreed Dignified Willy. "For us firin's a insult, but quittin's O.K. I rate a apology, I do."

"Yes," nodded the President. "And I hereby apologize to you, and declare you are now and never will be, fired for sleeping on the job."

The crowd started to cheer, and I thought if this is tact, it's easy, you just give people what they want. But the President wasn't finished and held up his hand for silence.

"And now Mr. Willy," he added, "since you have quit, I accept your resignation, to take effect at once."

There was no cheer for this, only silence, but Dignified Willy got right down off his barrel, and his waxed mustaches opened up into a big smile.

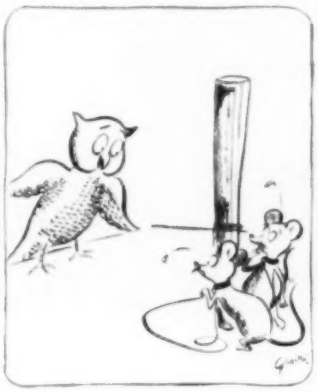
"Sir," he said, "my honor is now satisfied. But I didn't quit and I ain't quittin'. Since I bin apologized to by the President hisself, I got no reason to quit. So you'll find me right here, sir, on the stills, any time you care to come around."

I thought for a minute the President was having a stroke, he got so stiff. Then he gave a kind of laugh, took the Boss by the arm and they got into the limousine.

"10 cents for the Chief?" I yelled tactfully through the window.

"15" said the Boss, and they drove away.

I hope Oscar likes his mice. They're the fattest in town.



"Yes," nodded the President. "And I hereby apologize to you—"

FUEL OILS

(Continued from page 71)

In the catalytic cracking process, the same reaction occurs as in the thermal cracking, but it is obtained by a different method. Material for catalytic cracking is also straight run, but thermally cracked products, especially No. 2 distillate, are used at various times.

As in the other two processes, the charge is first heated. This material is either vaporized to the gaseous state, or kept in the liquid condition as it is introduced into the reactors. These reactors contain the catalyst, which produces the necessary cracking of the oil, or vapors. This catalyst may be in a finely divided form, which mixes with the oil, or it may be in the form of pellets, or balls over or through which the vapors pass. After the cracking has been completed, the products are run through the fractionating tower, as in the other processes, and then into the storage tanks.

The products obtained by this method are usually as follows:

Gasoline
No. 2 distillate

Meaning of a Catalyst

A catalyst is a substance, usually a chemical compound, imbedded on certain types of inert material, which can either increase, as well as retard a chemical reaction, depending upon type, without itself entering into the reaction products, or undergoing a chemical change. By its presence within the refining structure, the catalyst accomplishes the necessary cracking, which the high temperatures and pressures in the thermal process produced. As it does not enter into the reaction products, or is destroyed, it may be used over again. To mention a few catalysts, sulphuric acid, aluminum chloride, various oxides, such as vanadium and nickel are used.

Differences in specifications and characteristics, which the various fuel oils possess, due to the methods of refining, will be described and discussed in the succeeding parts.

IT'S WHAT YOU DON'T SEE THAT Cripples POWER PLANTS!

You run the risk of lowered efficiency — even plant shutdown — when you fail to protect your power generation equipment against attacks of scale, embrittlement, carry-over and corrosion! The following Allis-Chalmers corrective chemicals, recommended and applied by specialized water-conditioning engineers, are available to solve all of *your* costly water and steam troubles.

AKON TREATMENT — An effective oxygen absorbent and sludge coagulant for boilers, either internally or externally treated.

AKON BRICKS — A solid composed of Akon treatment and softening chemicals for internal treatment in low to medium pressure ranges.

No. 26 INTERNAL TREATMENT — Used as oxygen scavenger and sludge dispersive agent for boilers, either internally or externally treated.

No. 30 SERIES — Powdered formulations combining all of the necessary softening chemicals with an organic dispersive material.

SILIMITE TREATMENT — Effective high magnesium dolomitic lime for silica reduction in connection with a hot process lime-soda softener.

No. 40 SERIES — Powdered formulations for scale and corrosion control as supplementary treatment for boilers in *all* pressure ranges.

No. 160 SERIES — A liquid formulation consisting of the volatile amines for corrosion control in condensate return systems.

No. 20 SERIES — Powdered formulations designed to control excessive scale and corrosion problems in plant cooling cycles.

No. 60 SERIES — Powdered formulations for inhibiting corrosion in brine and circulating water systems and low pressure boiler plants.

A-C ANTI-FOAM — An effective formulation to overcome damaging foaming in power plant boilers operating over 150 psig.

HENRY W. FINK, with over 10 years experience in power plant water conditioning, is one of the Allis-Chalmers specialists located around the country to advise you on correct water conditioning equipment, chemicals and service. For free survey, call your nearby Allis-Chalmers office.

FOR OVER HALF A CENTURY, Allis-Chalmers has been building power generation equipment. This experience provides our water conditioning specialists with the extensive background needed today to recommend, not only correct equipment, but chemicals and service as well.

Whatever your industry — paper, petroleum, food, steel — an expert Allis-Chalmers representative is available, ready to recommend proper chemicals or help select the right process for your power plant requirements. Get in touch with him today at your nearby Allis-Chalmers Office.

Akon and *Silimite* are Allis-Chalmers trademarks.

ALLIS-CHALMERS

Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

Gentlemen:

Please send me specific information on the following chemicals:

_____

_____

Name _____

Title _____

Company _____

Address _____

City _____ State _____ A-2083

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOU HAVE a question about some detail of power plant operation, maintenance, design. You can't find the answer in your own experience nor in the books. So you write in to our editors. If we know the answer, we send it right back to you. (Maybe we don't know the answer either, but we usually know where to get it for you.)

In any case, we publish your question, signed only with your initials. We do not reveal your identity.

Dozens of engineers write in to us, giving their answers. We forward you copies of the replies as soon as we get them.

You, too, cooperate with other engineers by answering their published questions in the same way.

Then, so far as space permits, we publish those replies as soon as possible, so that everybody will learn what the others know about the problem. We pay well for all answers published. And those who answer get credit for knowing.

Simple, isn't it? And effective? Just ask the power engineer who has tried it!

Engineers who take the trouble to answer your question would appreciate some information from you, transmitted through the Q & A editor, on how their answers helped solve your problem. In doing this, indicate whether or not your comments could be published for the benefit of all readers.

Question No. 459

HOW OFTEN SHOULD STANDBY DIESELS BE RUN?

WE HAVE 2-75 kw General Motors Diesel Generators which we use as standby equipment. They are used in case of power failure. We use a special Diesel crankcase oil and a No. 2 Diesel fuel oil. We have a battery charger to keep the starting batteries up where they belong.

My question is, is it all right to allow the Diesels to set without starting them until needed for service, which may be a month or more, or should they be run every two weeks? I do not want to operate them more than necessary so as to keep them in good condition.

Greencastle, Ind. C.F.M.

Question No. 460

WANTS ELECTROMAGNET TO REMOVE STEEL SHOT FROM BOILER HEADERS

WE WOULD LIKE to make an electromagnet to remove steel shot from steam boiler headers in the process of manufacture. These headers range in size from 10 in. I D to 20 in. I D. The magnet would have to be made in such a manner that it could pass through an elliptical hand hole $3\frac{1}{2}$ by 5 in.

I would appreciate any information any of the readers could give me in regard to the design and construction of such a magnet.

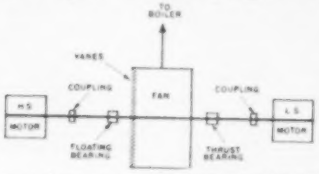
Cornwells Heights, Pa. R.C.I.

Question No. 461

WHY DO THRUST BEARINGS WEAR OUT?

WE HAVE a 150,000 lb per hr boiler with a No. $4\frac{1}{4}$ type W, single width, single inlet fan equipped with vortex control and inlet box. This fan is driven by two motors, coupled one on each end with flexible couplings. The low speed motor is 60 hp at 865 rpm and the high speed motor is 125 hp at 1165 rpm.

We've been having trouble wearing out thrust bearings on this shaft, having used eight bearings since February 1947. We've tried realigning shaft and couplings. We have changed to a lighter grease on recommendation of our lubricating engineer, since we thought that the grease might have been the trouble as this is an outdoor (on the roof) installation. We are using SKF No. 22222 spherical self-aligning roller



type bearings. The shaft is 4-13/16 in. in diameter. This boiler is operated at about 110,000 lb per hr, running fan at high speed.

Do we get too much thrust? The louvers are about 1/3 open. Should we house in and heat the bearing in the winter? All except one bearing failed in cold weather. Also, bearings do not give any warning by overheating and the only way we know a bearing needs replacing is when spacers wear and chip and bearing begins to "howl" or "whine."

Should we install heavier bearings?

East Alton, Illinois J.T.

New ENGINEERING BOOKS

Industrial Electronics, by Andrew W. Kramer. First Edition; 311 pages; 229 illustrations; $6\frac{1}{4}$ by $9\frac{1}{2}$ in.; cloth. Published by Pitman Publishing Corp., 2 West 45th Street, New York, N. Y., 1949. Price $6.00.

In simple, clear language this book explains the fundamental principles of electronics without using mathematics, and shows how these principles are applied in industry. It tells what electron tubes are, how they were evolved and how they work. The book is designed particularly for the practical man in the industrial plant who wants to know how the new methods and equipment of electronics can be used for improving maintenance and operations in his plant. The book is written for those who have a good knowledge of general physics and engineering, but who have had little or no experience with electronic equipment. To a certain extent it is a beginner's book. It explains step by step in simple, concise language what electron tubes are and what they can do in industrial processes.

Beginning with a brief historical background and a consideration of the electron theory of matter, it proceeds to a discussion of the fundamental principles of the electron tube in a more or less chronological manner. This chronological treatment is desirable because it gives the reader a historical perspective that will help him in understanding the reasons for certain developments. Considerable emphasis is placed on the diode—the simplest of all thermionic tubes—because the same basic principles which govern the operation of the diode also govern the operation of the more complex tubes considered in later chapters.

In explaining the action of the tubes, nothing is taken for granted. No new principle or action is introduced until the fundamentals underlying such principles or actions have been clearly explained.

The basic material for much of this book appeared first as a series of articles on electron tubes, published in *Power Plant Engineering*, from 1936 to 1939. The present volume, however, is completely new. Nearly all the original material was rewritten or revised, a great deal of new material added and the whole work brought up to date.

For anyone interested in all the various new uses of electronics, this book should be of considerable practical value.

• • •

ASTM Standards of Industrial Water, by ASTM Committee D-19; 142 pages, illustrated; size 6 by 9 in.; paper binding. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pennsylvania. Price $1.75.

This new compilation, prepared by ASTM Committee D-19 on Industrial Water, brings together in convenient form the various ASTM standard methods of sampling, analysis, and testing of industrial water for use of all those interested in this field. These methods have been developed particularly for the examination of water employed industrially in the generation of steam or for process or cooling purposes and for the examination of deposits formed from such waters.

The publication includes 26 methods which cover sampling, analysis, corrosivity tests, methods of reporting and general testing methods. A list of ASTM symposiums and technical papers on industrial waters is also included.

The ASTM also has available a reprint of a round-table discussion on the need for standards for the examination of waterborne industrial wastes.

• • •

Theory and Design of Gas Turbines and Jet Engines, by E. T. Vincent; 604 pages, illustrated; size 6 by 9 in.; cloth binding. Published by McGraw-Hill Company, Inc., 330 West 42nd Street, New York City. Price $7.50.

The author, who is professor of mechanical engineering at the University of Michigan, has prepared this book as a text in the field of gas turbines in which the theory and practical applications of that theory to specific design problems are included.

There has been a deluge of technical papers on all phases of gas turbine theory, design, control and so on, but not too much has been published on how to apply

BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

PITTSBURGH • BOSTON • CHICAGO • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • SYRACUSE

For New England: New England Coal & Coke Co., For Export: Castner, Curran & Bullitt Inc.

the theory in a workable manner to a practical problem. In addition, the aeronautical approach to the compressor problem is in a language somewhat unfamiliar to the mechanical engineer.

In this text, an effort has been made to bring the aerodynamic and gas dynamic problems down to a point where the general engineering studet without aeronautical background can understand the main problem involved.

The materials are arranged so that the theoretical treatment can be given in one course, such as to a senior mechanical engineering group, and the application to a specific design problem given as a subsequent course to graduate students. The author admits that there is some duplication in parts of the text, but points out that this was done deliberately to present the same material in a different form spaced some time apart, in order to impress it on the mind better than a concentrated presentation at one point.

The book is well illustrated with diagrams and photographs of actual gas turbine components and their performance. Problems are given at the ends of the chapters, also lists of the reference works, and a bibliography at the end of the book.

In a pocket on the inside back cover is the well known chart of Thermodynamic Properties of Air reproduced with permission of the Bureau of Ships of the Navy Department. Portions of this were reproduced in this magazine in the series of articles entitled the Gas Turbine Power Plant by John I. Yellott, one of the few discussions of the gas turbine from the practical, engineering point of view.

• • •

Electrical Transmission of Power and Signals by E. W. Kimbark. First Edition; 461 pages; 6¼ by 9 in.; cloth; illustrated. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1949. Price $6.00.

This excellent book on electrical transmission is somewhat different from most books dealing with the electrical transmission of power, because it is probably the first book ever written that presents the basic theory of transmission lines, together with applications to the three fields of power, telephony and ultra high frequencies. Yet, no novelty is claimed by the author for incorporating both power and communication theory in one book. Indeed, as Dr. Kimark points out in the preface to his book, in 1927 he took an excellent course of this nature under Professor Lester E. Reukema at the University of California. It was the taking of this course and the teaching of it the next year when Professor Reukema was on sabbatical leave that awoke Dr. Kimbark's interest in transmission theory.

While the book is intended as a text for junior or senior students in electrical engineering, it should also be of great value and interest to practicing electrical engineers. In the past, many electrical engineering curricula have had either required or elective courses in electric power transmission or in electrical communication or both. The power transmission courses included fundamental transmission line theory and its application to power systems and the communication courses included the same fundamental transmission line theory and its application primarily to telephone systems. Obviously, as the author points out, it is a wasteful duplication of effort to teach the same basic transmission theory in two or three different courses in one school, and that is one reason for his inclusion in one book of the basic theory relating to transmission both in the power and communication field.

The book assumes that the students will have had the usual courses on a-c and d-c circuits, with lumped-parameters but none on electrical machinery or on electron tubes. This text will give them their first detailed treatment of circuits with distributed parameters.

Dr. Kimbark is Professor of Electrical Engineering at Northwestern University. He has been teaching electrical engineering for 18 years and has specialized in power system problems, but also kept up his interest in communication. During the World War he lectured on radio frequency lines and wave guides at the MIT Radar School and edited the first edition of its textbook, Principles of Radar.

• • •

Photoelectricity and Its Application by V. K. Zworykin and E. G. Ramberg. First Edition; 494 pages, 6 by 9¼ in.; illustrated; cloth. Published by John Wiley & Sons, Inc. 440 Fourth Avenue, New York 16, N. Y. Price $7.50.

In 1887 when Heinrich Hertz was conducting his classical researches on electric waves which subsequently led to the development of radio in all its ramifications, he noticed another curious phenomena which, if not of equal importance to his discovery of electric waves, is at least a close second. This was the photoelectric effect. Hertz noticed that an electric spark would jump across a spark gap more easily if the gap was exposed to ultraviolet light than when the ultraviolet radiation was not present. It was a comparatively slight effect but Hertz was an extremely observant scientist and so he investigated the phenomena. Subsequently it was shown that the effect was due to the emission of electrons from metallic surfaces when they were exposed to various types of electromagnetic radiation. This photoelectric effect today not only lies at the base of our whole television industry, but it has innumerable applications in industry and in many fields of scientific research.

Because of the great importance of the photoelectric effect in modern industry and scientific research, this book by Zworykin and Ramberg is very welcome. Although this is the first edition of the book, actually it replaces a previous book entitled, "Photocells and Their Application" by Zworykin and Wilson. This present book retains the aim of its predecessor to present the reader with practical, reliable data on the properties, preparation and applications of photoelectric devices. So many developments have taken place in this field since the publication of the Zworykin-Wilson edition that the new book is about twice as large. It aims to give an integrated representation of the whole field of photoelectricity covering basic principles, methods of preparation, photocell circuits, and the various principal fields of application of photoelectric devices.

The book begins with a brief account of earlier developments in the field of photoelectricity and is followed by a discussion of light sources and the basic principles of the photomissive effect.

The tone of the book is primarily practical. It includes circuit diagrams, graphs and other illustrations designed to allow the reader to use the material directly. Mathematical developments are restricted to footnotes. This does not interrupt the reader's train of thought and allows the text to be followed by a person with little mathematical training.

The book contains full discussion of phototubes, photoconductive cells, barrier-layer cells, and other photoelectric devices with respect to basic mechanism, preparation, utilization and application.

Vladimir Zworykin hardly needs to be introduced to those who have any knowledge of radio and related developments. At the present time Dr. Zworykin is Director of Electronic Research and Vice President and Technical Consultant of the Radio Corporation of America. It was Dr. Zworykin while engaged in research for the Westinghouse Electric Corp. who developed the iconoscope, forerunner of all modern high-sensitivity television camera tubes. Dr. Ramberg is at present Research Physicist for the RCA Laboratories. Dr. Ramberg moved to this position from a similar one with the RCA Manufacturing Co. His undergraduate work was done at Cornell University to which he returned as Research Assistant in 1932, after having completed graduate work and receiving his Ph.D. at the University of Munich.

• • •

Electronic Instruments, edited by Ivan A. Greenwood, Jr., J. Vance Holdam, Jr., Duncan MacRae, Jr. First edition; 721 pages; 6½ by 9 in.; illustrated; cloth. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1948. Price $9.00.

This book is the 21st volume of the Massachusetts Institute of Technology's Radiation Laboratory Series. The tremendous research and development effort that went into the development of radar and related techniques during World War II resulted not only in hundreds or radar sets for military use but also in a great body of information and new techniques

"Look, Casanova Brown—is that the kind of turbines you came here to the show to see??"

Only USKORONA is resistant to both moisture and ozone

USKORONA SPLICING COMPOUND
US
¾ IN. WIDE
30 FT. ROLL
OZONE AND MOISTURE RESISTING COMPOUND
Uskorona combines maximum resistance to OZONE and MOISTURE with high tensile strength, elongation and dielectric resistance. Fuses quickly without heat or pressure and makes P E R F E C T SPLICES.
MADE IN U.S.A.
United States Rubber Company
LET US SEND YOU A SAMPLE
U.S.RUBBER
SERVING THROUGH SCIENCE

Engineers of U. S. Rubber Company developed Uskorona because they believe a tape should be resistant to moisture *as well as* ozone.

That is why electrical engineers insist on Uskorona in the design, installation, operation and maintenance of power lines where corona (ozone) or moisture is a problem. Uskorona provides ideal insulation in splicing or jointing electrical cables on underground power lines, on secondary network systems, underground street lighting circuits, and transformer leads.

Remember, only Uskorona gives you the two-fold protection against moisture *and* ozone. Write to address below.

UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION, ROCKEFELLER CENTER, NEW YORK 20, N. Y.

What Other Drive Gives You...

1. SIMPLICITY, LONG LIFE

So simple that it can be serviced by relatively unskilled mechanics...so rugged that it stands abuse that would wreck other drives...so dependable that it is consistently used where unfailing service is imperative — these are typical advantages gained from the Troy steam engine's basic simplicity. Long life, also, stems from this inherent simplicity and ease of maintenance. Year after year, under the most adverse conditions, Troy Steam Engines continue to deliver dependable, low-cost power.

Plus-

2 ACCURATE, FAST SPEED CONTROL

3 BY-PRODUCT POWER

4 HIGH STARTING TORQUE

5 UTMOST FLEXIBILITY

Year after year: Up in the air, out in the open, the Troy Steam Engine continues to drive this kiln in an asphalt paving plant after many years of dependable operation.

Which Do *You* Need?

If your drive needs any or all of these five characteristics, the modern Troy Steam Engine is indicated. Send us your drive requirements and steam conditions, and our engineers will be glad to recommend the right type and size Troy engine to meet your needs.

Send for Bulletin 306

TROY

Troy Engine & Machine Co.

Power Equipment Division

2102 RAILROAD AVENUE • TROY, PENNSYLVANIA

in the electronics and high-frequency fields. Because this basic material is of great value to science and engineering it seemed most important to publish it as soon as security permitted.

As pointed out in the preface, the title of this book, Electronic Instruments, carries with it the implied adjective "some." The specific kinds of electronic instruments which are treated are electronic analogue computers, instrument servomechanisms, voltage and current regulators and pulse test equipment. Aside from the common denominator indicated by the title, these four types of equipment share claims as important adjuncts to many modern radar systems.

The book is arranged in five parts. Part I gives examples and uses and describes the step by step methods used in the design of electronic computers; Part II illustrates the potentials for new applications of servomechanisms and gives the procedures and techniques used in the design of instrument servomechanisms; Part III analyzes simple and degenerative generators; Part IV is devoted to the general subject of pulse test equipment; and Part V considers the design and construction of electronic apparatus in general. The work of many men and many different organizations, this book contains a wealth of information which can be applied in many different fields.

HELPFUL BULLETINS

(Continued from page 36)

129 Welding Fittings and Flanges—Titled, "Catalog and Engineering Data Book 211," this handsomely bound 262-pp manual provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different types of piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys and their specific applications. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

Distribution of this excellent piece of industrial literature is limited to major users, designers and erectors of industrial piping. (Please include your title when requesting it.) Names of those who receive copies will be registered for company's supplemental data and literature. Tube Turns, Inc.

130 Electrostatic Precipitation—Sixteen-pp Bulletin GEA-5212, profusely illustrated with photos and diagrams, explains how electrostatic precipitation works, gives case histories of seven typical installations where the system is being used, and describes the various methods of electrostatic precipitation and the electric equipment applicable to each method. Discusses air cleaning, gas cleaning and recovery, other applications. General Electric Co.

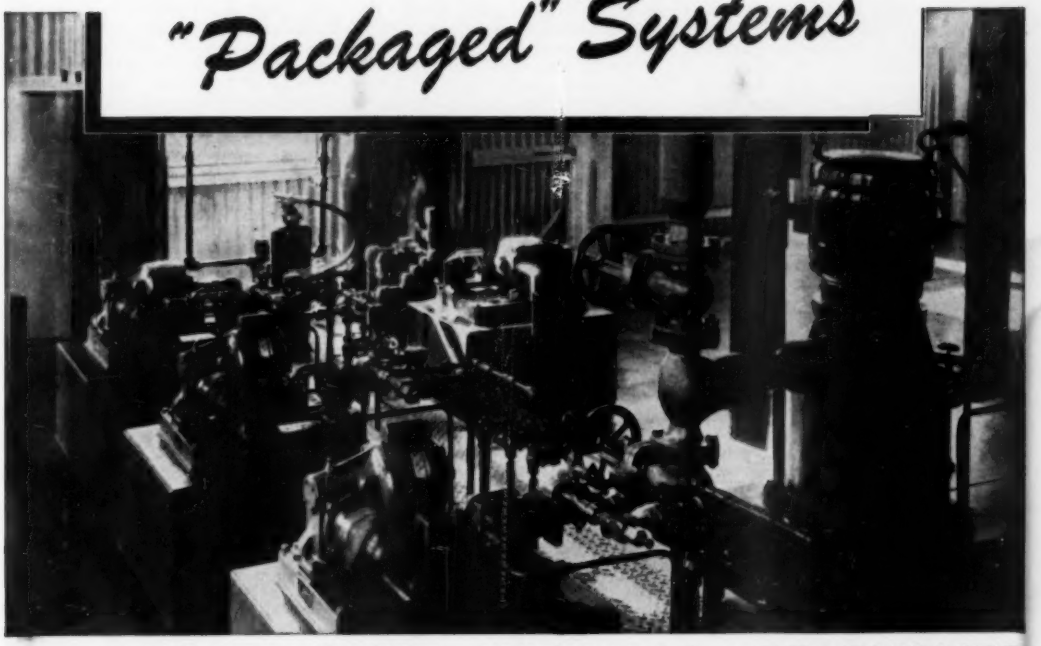
131 Micarta Data—Booklet B-3184-D is company's revised 36-pp data book on Micarta. Published as a working tool for designer and user of industrial materials, it presents clearly and completely the technical facts about Micarta. The grades and forms in which this industrial plastic is supplied are tabulated, together with chemical, mechanical and electrical properties of each. Standard shapes and sizes available are listed, and a description of finishes is included. Westinghouse Electric Corp.

132 Fluid Reduction Mills—Bulletin 430-1, 8-pp, introducing company's fluid energy reduction mill, discusses the advantages of finer particle size in many processing operations. Illustrates the mill and explains its grinding operation. C. H. Wheeler Mfg. Co.

133 Cooling Towers—Bulletin AQ-50, 4-pp, introduces company's improved packaged water cooling towers in 3 to 50 t sizes. Gives specifications for the tower and discusses special features. Also provides dimensional and application data covering the five standard and three large sizes. Illustrations include photo of an installation. The Marley Co., Inc.

MILTON Roy

"Packaged" Systems



for BOILER WATER CHEMICAL TREATMENTS

The necessity is well recognized for feeding various chemicals to boilers for the prevention of scale and to control alkalinity, remove dissolved oxygen, protect against embrittlement and insure against corrosion and pitting caused by impurities in the boiler feed water. Practically all competent authorities agree that two distinct methods for conditioning boiler water are necessary.

First. sodium sulfite should be fed continuously to the suction side of the boiler feed pump to react with and remove any residual dissolved oxygen in the boiler feed water. This is necessary because oxygen in the water will act to corrode and pit the boiler feed water pump, economizers and boiler drums and tubes.

Second. other internal treating chemicals should be fed directly into the boiler drums to precipitate incrusting solids, to control alkalinity, and to give a chemical balance in the boiler to prevent corrosion and embrittlement.

Typical Milton Roy "Packaged" Systems for boiler water treatment are illustrated above. These systems are complete, include all necessary solution tanks, covers, gage glasses, low-level cutouts and alarms, motor starters and pumps as required. Automatic electronic controls can be supplied to operate pumps at speeds proportional to feed water flow as measured by flow meters. Systems are available to handle all treating chemicals and to meet all capacity and pressure requirements.

For complete information, ask for Bulletin 4811 and Technical Paper No. 51 "What the Power Engineer Needs to Know about Chemical Feed Systems."

MILTON Roy COMPANY

1320 E. MERMAID LANE, CHESTNUT HILL, PHILA. 18, PA.

New Steam Generating Plant Serves Columbia Steel's New Cold-Reduction Mill

NEW STEAM GENERATING equipment has been installed at its Pittsburg, California, plant by Columbia Steel Co., to serve the new cold-reduction mill recently added to the already diverse facilities of the plant. The new mill will produce cold-reduced sheet steel and tin plate to supplement the wide variety of steel products this United States Steel Corp. subsidiary has long supplied to meet the expanding needs of the West.

The new steam generating plant consists of two four-drum boiler units, designed to supply a continuous output of 58,000 lb of saturated steam per hour per boiler for a minimum two-hour period. Built in accordance with the latest code, the two boiler units were designed for 200 psig, with an operating pressure of 175 psig.

Three combination gas and oil burners fire each boiler. Steam is used for oil atomization. Efficiency of the combustion system is 75 per cent on gas firing, and 82 per cent on oil firing. The stacks are of the self-supporting type, braced with structural steel framework.

The induced-draft fans for the boilers have steam-turbine drives with built-in gear units. Capacity of each blower matches the maximum capacity of the boiler units with a 25 per cent margin.

Two-stage centrifugal pumps supply feedwater to the boilers. These have direct-connected steam drives, and each pump has a capacity sufficient to supply the two boilers operating at maximum capacity. The feedwater heater is heated by exhaust steam from boiler auxiliaries, supplemented by live steam. Capacity of the heater is based on 100 per cent cold water make-up for the two boilers at full capacity. Feedwater supply is automatically regulated.

The feedwater conditioning system consists of a double-unit softening installation that is automatic in operation. It utilizes two processing tanks 84 in. in diameter and 66 in. deep containing the softening agent, with auxiliary brine tanks, control meters, valves, and other equipment necessary for its operation. Conditioning of feedwater also involves a phosphate feeder and an automatic lime-soda feeder. Capacity of the boiler feedwater conditioning system is amply sufficient to meet the needs of both boilers operating at full capacity.

The continuous blow-down system incorporates a blow-down tank constructed of concrete, approximately 4 ft by 6 ft, installed underground, with target, overflow, and accessories.

Two motor-driven gear pumps having individual capacities for handling 10 gpm at 100 psig are provided for the fuel oil system, along with a horizontal duplex steam-driven pump with a capacity of 27 gpm at 100 psig. Two steam-heated fuel oil heaters have also been provided. Fuel oil is stored in a 15,000-gal horizontal tank installed underground.

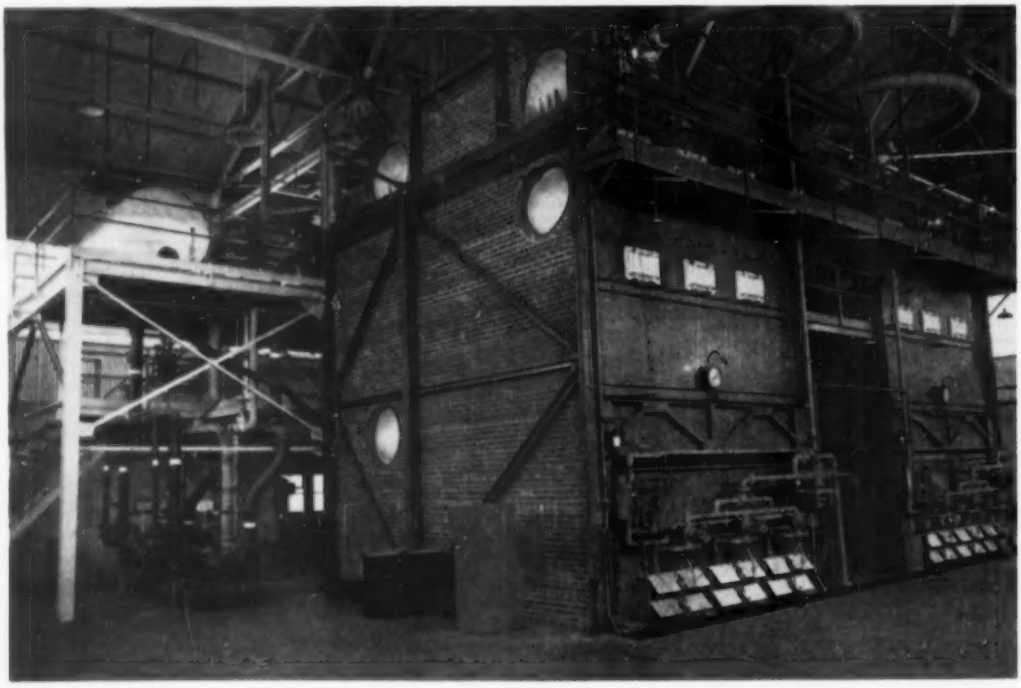
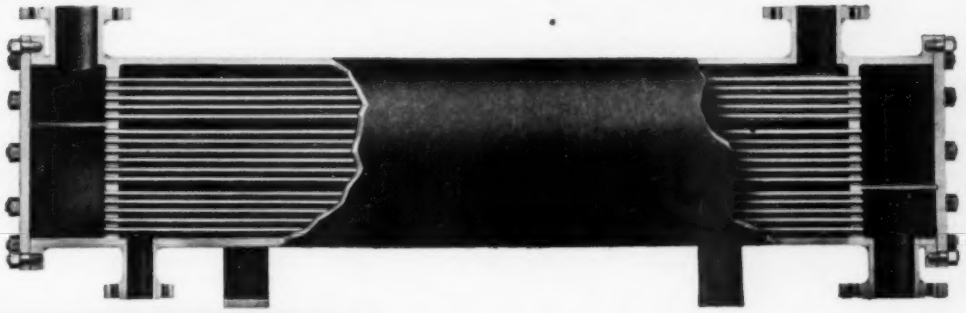


Fig. 1. View of the two four-drum steam generating units, each designed to supply 58,000 lb of saturated steam per hr at 175 psig, for meeting the steam requirements of the new sheet and tin mill of Columbia Steel Co. at Pittsburg, Calif. Normally gas-fired, the boilers are provided with facilities for emergency use of fuel oil. Boiler feed pumps on operating floor at left

Take Your Choice for
FUEL OIL HEATING

G-R TWIN G-FIN SECTION



G-R TYPE B TUBULAR HEATER

G-R offers you the choice of two different designs of fuel oil heater. Both designs are of long-proven heating effectiveness and dependability. Both designs have readily accessible tube interiors and are easy to keep clean. Both designs are of sturdy construction and are lastingly secure against leakage.

If your requirements are for the heating of large quantities of oil, you want the compact, easily handled G-R Type B Heater.

Where your requirements are for moderate or small quantities, with great capacity flexibility and a minimum of spare equipment, you want the G-R Twin G-Fin Section.

Write for full information on each of these units, and for advice as to the most suitable type of heater for your particular plant conditions.

THE GRISCOM-RUSSELL CO., 285 MADISON AVENUE, NEW YORK 17, N. Y.

GR-237

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

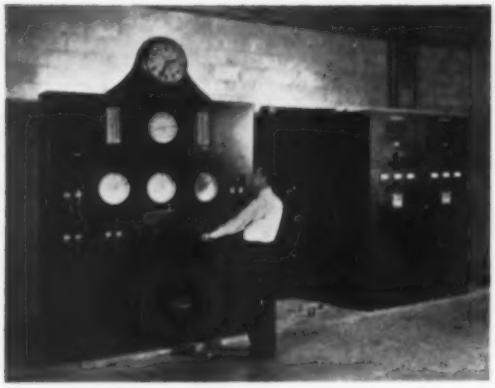


Fig. 2. Control panels for the steam generating plant at the new Pittsburg, Calif. sheet and tin mill of Columbia Steel Co.

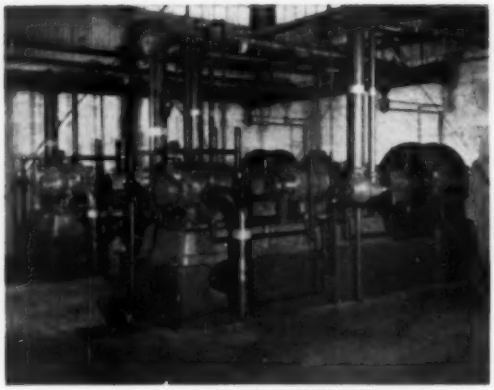


Fig. 3. Two rotary 2-stage air compressors, each driven by 350-hp, 2300-v, 600-rpm synchronous motor supply air for Pittsburgh plant

Instruments and controls that regulate operation of the plant include a combustion control for regulating fuel-air ratios on 100 per cent gas or 100 per cent oil firing. There are two electric recording and integrating steam flow meters, an integrating and recording gas flow meter, two three-point draft gages, and all other temperature and pressure gages and control units required for good boiler practice.

Air Compressors

Two two-stage rotary air compressors have also been installed in the boiler plant to supply compressed air for the new sheet and tin mill. Each compressor is driven by a 350-hp synchronous electric motor, operating on 2300-v, 60-cycle, 3-phase, alternating current. Two 54-in. diameter air receivers, each 14 ft high, have been installed for storage of compressed air. The two aftercoolers of the air system have corrosion-resisting tubes and tube sheets, and incorporate moisture traps and oil separators.

Each compressor is equipped with an inlet air filter and silencer units. Lubrication is through a motor-driven pressure system.

Complete full-magnetic electrical control equipment has been provided for the compressors, each of the two sets being mounted in dead-front, totally-enclosed panels.

Steam Sampling Method

TENTATIVE method of sampling steam has lately been accepted by the ASTM under designation D-1066-49T, for use pending its formal adoption as standard. It covers the sampling of either saturated or superheated steam flowing in a pipe or conduit at a pressure above that of the atmosphere.

An important requirement in the sampling of fluid streams carrying particles in suspension is that the velocity entering the ports of the sampling nozzle shall be the same as that in the stream being sampled; also, that each port of a multiport sampling nozzle withdraw a portion of the main stream equivalent to the area of the portion of pipe or duct in which it is located.

Required Apparatus

As reported in *Combustion*, the apparatus consists of a steam sampling nozzle, the necessary piping, valves and fittings; and, when required, a sample condenser and cooler. The recommended form of sampling nozzle extends to within $\frac{1}{4}$ in. of the opposite wall and has 4, 6 or 8 ports according to the inside diameter of the pipe of 2 to 6 in., over 6 to 12 in., and over 12 in., respectively. The nozzle is tapped into the pipe. Each port represents an equal area of pipe section and their size is such that the ratio of their total area to that of the pipe is equal to the ratio of rate of sample flow to rate of stream flow. A sampling nozzle for use in small tubes carrying high pressure is also provided. Care should be taken that the nozzle ports face upstream.

When the sample is analyzed for moisture content by means of throttling or separating calorimeters, the rate of flow is fixed by the characteristics of the calorimeter. When the steam is to be condensed or cooled for specific conductance measurements, or for the evaporative method of analysis, the sampling nozzle may be designed for maximum rate of stream flow and the rate of sample flow may be adjusted for lower rates of flow.

The shortest possible connection shall be used between the sampling nozzle and the calorimeter or cooling coil.

For use with a calorimeter the valves, connecting piping and fittings are of carbon steel; but when the sample is to be condensed or cooled, the connecting piping and fittings must be of stainless steel. A tubular heat-exchanger may be used.

The sampling nozzle shall be located after a run of straight pipe of a length equal to at least ten diameters, with preference for downward flow in a vertical pipe. Moreover, it shall not be located immediately after valves or bends. When a boiler is arranged with multiple tubular connections from the drum to a superheater header, samples shall be taken from selected tubes spaced across the width of the drum at no greater than 5-ft intervals; or they may be taken at the inlet header of the superheater. For long headers, samplers should be installed at each end of the header.

When a new sample line is being put into service, it is necessary to flow steam and condensate through it for 24 hr before samples are collected. Also before a sampling period, steam should be blown through the sample to remove any material that may have been deposited in it.

When samples of condensate are collected for evaporative analysis, the flasks or other containers should be meticulously cleaned before using, and the samples should be analyzed as soon as possible after they have been collected.

The sampling rate is determined by the relation:

$$f = a/A \times F$$

where f and F are the sample flow rate and steam flow rate, respectively, and a/A is the ratio of total port area to pipe area.

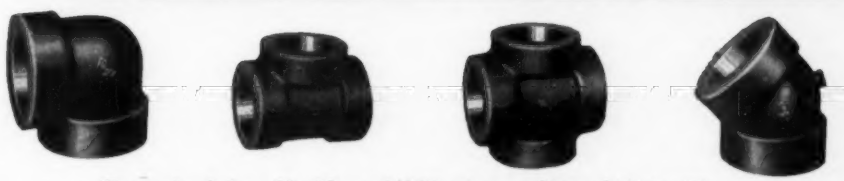
Copies of the complete Tentative Method of Sampling Steam may be had from the American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

STRENGTH

for Safety and Long-Time Service

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

SOCKET WELD TYPE

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

HENRY VOGT MACHINE CO., INC
Louisville 10, Kentucky
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Vogt
DROP FORGED STEEL FITTINGS

Babcock & Wilcox Installs New Laboratory

ENGINEERS who are concerned with the design, fabrication, and construction of boilers, turbines, petroleum refining equipment, chemical processing equipment—in short, most equipment that is to operate under conditions of high-temperature and stress—are constantly in need of accurate and complete data on the creep and stress rupture properties of carbon steel, alloy steel and other metals. Creep is the permanent deformation that occurs with time in metals subjected to stress at high temperatures. It is measured by placing test specimens in specially-designed furnaces, and keeping them under a predetermined stress and at constant temperature for long periods of time. Measurements are taken, usually by means of an extensometer, at regular intervals. Experience has demonstrated that long tests are necessary—nearly all of those made on the apparatus described below are now run to 10,000 hours or more.

The stress-rupture test is an overloaded creep test continued to actual failure, in which the time required to rupture the specimen at a given stress and temperature is determined. A series of test bars is subjected to static stresses of various magnitudes at the selected temperature level, and the time for fracture is determined. The stresses applied are of course much greater than those used for creep tests. The duration of the test may range from 100 hours to as high as 10,000 hours or more.

Creep and Stress-Rupture Data Important

Creep and stress-rupture data are of considerable value to manufacturers of steam-generating equipment—for example, in connection with rolled-in joints, superheater tubes, headers, baffles, fittings, etc. Turbine builders are also vitally interested; for example, alloys for turbine wheel forgings and blades must be selected so that binding will not occur at operating temperatures and pressures.

Fig. 2. Twelve-station units for studying stress-rupture characteristics of metals built at the Alliance, Ohio, laboratory of the Babcock & Wilcox Co.

The daily extension or creep of a specimen varies with load, temperature, and characteristics of the material being studied. It may be as low as five micro-inches per day (the smallest division on a standard machinists' micrometer caliper is 1,000 micro-inches). Maximum creep is as high as 250 micro-inches per day (about one-fourth of a division on a standard micrometer).

Perhaps the earliest attempt to investigate creep and stress rupture on an extensive scale was the establishment, by The Babcock & Wilcox Co. and The Babcock & Wilcox Tube Company, in 1926, of a joint fellowship at the Massachusetts Institute of Technology, under the direction of Professor F. H. Norton.

Apparatus Moved to B & W Laboratory

In recent months, the apparatus originally designed by Prof. Norton and B & W engineers, and used at M.I.T., was moved to The Babcock & Wilcox Company's new research and development laboratory at Alliance, Ohio. Twenty stations, designed for creep tests, but usable for stress-rupture tests, are available. In order to achieve optimum accuracy, multiple-circuit electronic controls, developed by B & W engineers, have been applied to these M.I.T. units; they are actuated by the expansion of the furnace tubes, and make it possible to hold temperatures within plus or minus one degree F up to 1550 F. These units are therefore superior to commercial equipment now available. A ten-inch test specimen is used, the precision of the extensometer being six parts in a million. A change of less than 0.00001 inch (10 micro-inches) in the length of a test bar can be measured.

Owing to the possibility of expansion of the framework of the testing unit, it is necessary to keep the room temperature at a constant value. This is accomplished within plus or minus one degree—remarkably close control, when one considers the temperature range ordinarily found in homes having thermostatically-controlled gas or oil heat.

New Testing Equipment

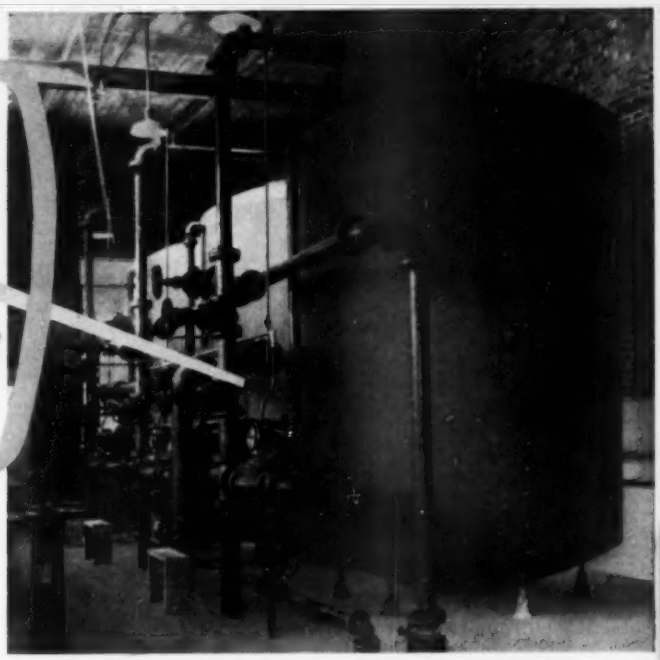
Additional facilities for creep and stress-rupture tests have been provided at Alliance by the purchase of 16 Baldwin-Southwark, single-station, lever-arm creep-testing machines. A maximum temperature of 1800 F, with controls holding the temperature to plus or minus two degrees, is obtainable. The gage length of the test specimen is 3.0 in., and the accuracy of the reading is approximately fifty parts in a million. These machines are also suitable for stress-rupture test.

The temperature of each specimen is continuously recorded on a strip-chart temperature recorder. This also applies to the 20 stations described above.

For the purpose of studying the stress-rupture characteristics of metals, four twelve-station units have been built at the Alliance laboratory.

Fig. 1. Front view of Baldwin-Southwark, single-station, lever-arm creep testing machines added to facilities at Alliance, Ohio laboratory of the Babcock & Wilcox Co.

ZEOLITE is right for purifying water here...



Worthington installation of three 8' — 0" dia. Sodium Zeolite Softeners put into operation in August, 1948 at Virginia Woolen Co., Middlebury, West Virginia. Here raw creek water is alum treated, settled, filtered and softened. Virginia Woolen Co. constructed its own filters.

. . . but it may not be right for your water treatment

This Worthington Ion-Exchange plant was installed for purifying water in this case, *only* after scientific analysis by Worthington engineers determined that it was the most economical process for Virginia Woolen Co.

In your case, there are so many variables involved that a similar analysis would have to decide which water conditioning process is right for you. Even within the ion-exchange process itself, there are many variables: what ions you want to get rid of . . . calcium, magnesium, sodium, bicarbonate, sulphate or chloride; whether or not you want alkalinity removed; whether you want ionized water comparable to distilled water. *Only* scientific study of your particular water conditions can determine the right process for you.

WORTHINGTON KNOWS ALL FOUR PROCESSES

Out of Worthington's century-old experience in engineering water handling equipment has come more knowledge and skill in solving complicated water conditioning problems than you can get anywhere else. And since Worthington alone makes every essential part of all kinds of water conditioning systems, you get the extra advantage that comes from placing complete control and responsibility in the hands of one reliable manufacturer.

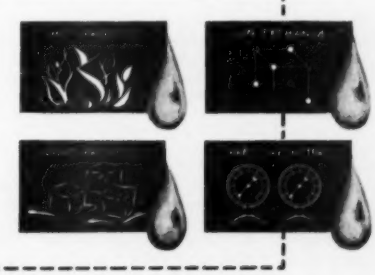
For complete details about the Worthington Ion-Exchange process, and further proof that *there's more worth in Worthington*, write for Bulletin W-212-B4. *Worthington Pump and Machinery Corporation, Water Treating Division, Harrison, New Jersey.*

J8-8

WORTHINGTON

WATER CONDITIONING

Worthington Makes More of the Equipment for All Types of Water Conditioning Systems



The furnaces are of annular design and each contains twelve circular chambers for the specimens. The temperature of each specimen is continuously recorded, and when a specimen ruptures the change in temperature serves to record the time of rupture. Excellent temperature uniformity exists in these large furnaces, plus or minus 3 F up to 1500 F being regularly obtained. Each unit is usually operated at a different temperature level.

The total capacity of the laboratory now makes it possible to perform 36 creep tests and 48 stress-rupture tests, or 84 stress-rupture tests, simultaneously. It is believed to be the most modern laboratory of its kind.

A standby power plant with a gasoline-driven generator has been installed, which goes into operation automatically in a matter of seconds if the regular source of electricity fails. This insures the accurate continuation of tests that might otherwise be interrupted after, say, 9,200 hours, when 10,000 hours' duration was desired.

NH_3 Liquid Level Control Increases Compressor Capacity and Improves Plant Operation

MATERIAL INCREASE in compressor capacity was one of the principal advantages resulting from the installation of an interesting ammonia liquid level control system at the plant of Shipper's Development Co., Salinas, California, some time ago. In the refrigeration plant serving this company are three ice tanks, in which the brine cooling coils are connected with the ammonia receiver as shown in the sketch.

To maintain optimum refrigerating capacity in this plant, it was desirable to protect against higher ice tank levels and also against possible flooding of the condenser as well as preventing carry over of liquid ammonia to the compressors.

It was desirable to maintain ammonia levels substantially equal in each of the three ice tanks and constant if the level in the receiver is within the operating range or higher, thus preventing carry over of liquid ammonia to the compressors. Furthermore, if the receiver level drops to a predetermined minimum it was desired that the level control on the receiver over-ride the ice tank level controls and shut down the ammonia flow.

To control these flows in the desired manner, a control system was designed and applied to the ammonia lines as shown in the accompanying diagram. The system was worked out by Associated Refrigerating Engineers of Los Angeles, together with Bailey Meter Co., which supplied the controls.

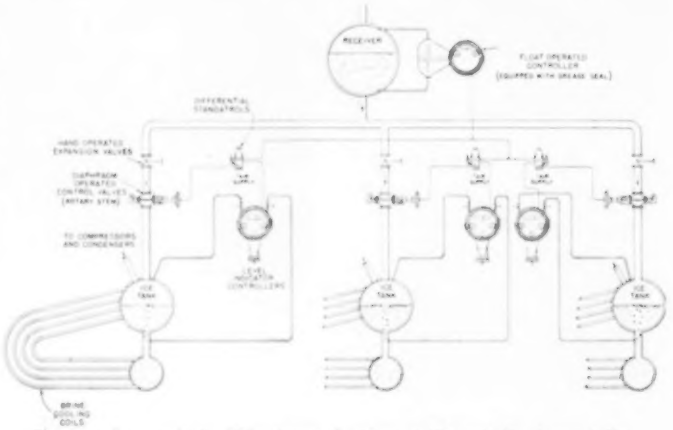


Diagram of ammonia liquid level control system at Shipper's Development Co.

How the Control System Works

Receiver level controller is calibrated and adjusted so that it cannot increase loading pressure beyond 50 per cent of control range regardless of level. Conversely, minimum control range is reached before minimum measured level.

Each ice tank level controller is adjusted so that the normal level is maintained at mid-range of the controller with minimum loading pressure of the controller corresponding to minimum level.

Level in each tank is held substantially constant until the receiver level drops to within range of its controller, which will then function to reset the standard of each ice tank level controller by action of individual differential standatrols.

If desired, the control can be calibrated so that ammonia receiver level control can over-ride the ice tank level controls and prohibit high receiver level and possible flooding of the condenser. In this arrangement, protection against possible flooding of the condenser is substituted in place of protection against high ice tank levels. This is desirable under certain operating conditions.

Ice-tank level indicator-controllers are mounted above the tanks so that ammonia vapor will be in both connecting lines of each unit. Vapor state exists in view of combination of pressure and ambient temperature. Vaporization of ammonia liquid in lower connecting piping produces a pressure equal to the pressure in the tank plus the head of liquid on the connection. This avoids difficulties due to unequal liquid legs on two sides of bellows.

One of the main advantages of the control system lies in the fact that the steady feed rate of ammonia obtained increases compressor capacity materially.

While the system illustrated does not employ means of remote hand operation of the ammonia valves, such devices are usually considered very helpful for transferring from manual to automatic control and vice-versa, and for routine maintenance procedure. The hand-automatic selector valve is especially valuable where standatrols or averaging relays are in the system between the controllers and the control valves.

COMING EVENTS

ASME—Oil & Gas Power Division conference, Lord Baltimore Hotel, Baltimore, Md., June 12 to 16.

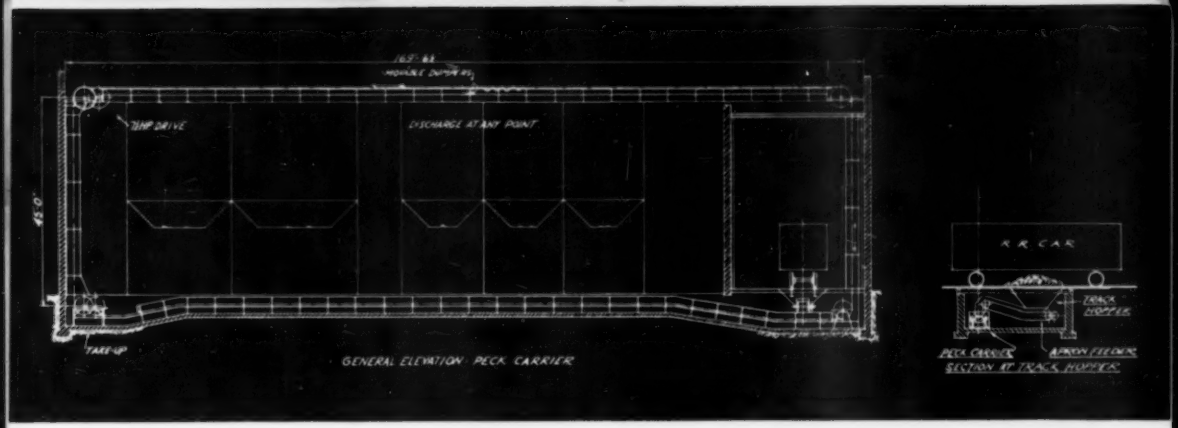
MPC—The twelfth annual Midwest Power Conference will be held at the Hotel Sherman, Chicago, April 5-7.

ASME—The Spring Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, Washington, D. C., April 12-14.

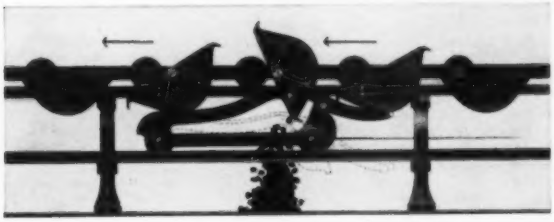
AIEE—American Institute of Electrical Engineers to hold its Power Conference at the Wm. Penn Hotel, Pittsburgh, April 19. Power Generation; April 20, Industrial Power Systems.

ASME—The Semi Annual Meeting of The American Society of Mechanical Engineers will be held at the Hotel Statler, St. Louis, Mo., June 19-23.

ISA—The 1950 Instrument Conference and Exhibit of the Instrument Society of America, will be held in the Memorial Auditorium, Buffalo, New York from September 18-22.



Coal handling **modernization** *pays off in textile plant*



LINK-BELT *Peck Carrier proves ideal solution*

The above illustration shows the operation of the movable tripper of the Peck Carrier, to permit coal to be dumped at any point on the horizontal run.

The problem at the power plant of Dominion Textile Company, Limited, at Magog, Quebec, Canada, was to increase the steam generating capacity and to modernize the coal handling system to cut unloading time.

The boiler and track layout proved ideal for the use of a Peck overlapping pivoted bucket carrier, which would follow a rectangular path in a vertical plane (as shown by sketch), with the coal being delivered by railroad car through a track hopper to an apron feeder discharging to the carrier for distribution along the top horizontal run into storage bunkers. The coal can be discharged at any point along top run merely by presetting the dumper mechanism that tilts the buckets.

The operation of the Peck Carrier is quiet and there is no vibration since the buckets move slowly. The capacity of this plant was set at 45 tons per hour, but this figure has been exceeded.

This is but one of the types of modernization equipment designed, built and installed by Link-Belt for both small and large plant operation. Ask our nearest office for details.

TYPES OF LINK-BELT CONVEYING MACHINERY

Belt Conveyors	Bulk-Flo Conveyors
Bucket Carriers	Screw Conveyors
Bucket Elevators	Car Unloaders
Flight Conveyors	Coal Crushers
Chain Conveyors	Weigh Larries
Apron Conveyors	Skip Hoists

LINK-BELT COMPANY Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

11,002

LINK-BELT

CONVEYING MACHINERY

"THE COMPLETE LINE"

How Waste Heat Recovery Saves Btu's For Schramm

RECOVERY of waste-heat from air compressors and their driving engines at the plant of Schramm, Inc., West Chester, Pa., is resulting in definite savings. The recovered heat supplies Btu's for which coal, oil or gas would have to be burned with any standard heating system.

In the Schramm plant, three 315 cfpm compressors, two driven by Diesels and the third by a spark-ignition engine using manufactured gas fuel, deliver about 400,000 Btu per hr into a system suitable for space or process heating.

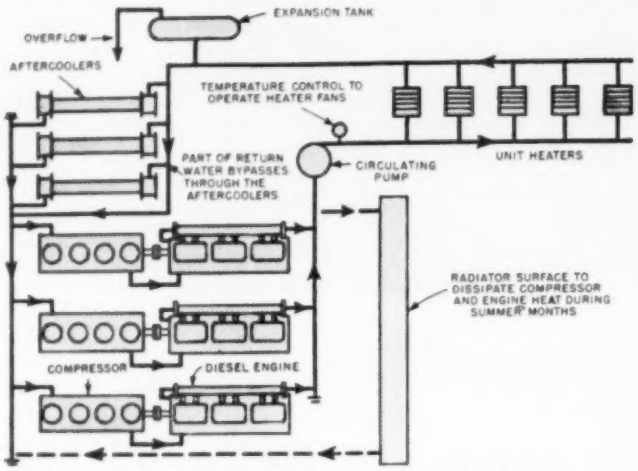
In a report recently published by J. L. Michener, plant engineer, the system for recovering waste heat is explained. The solution lies in making arrangements for heat recovery, so that cost of heat-recovery equipment doesn't consume the fuel savings that result.

In the Schramm plant, the engine compressors are teamed up with unit heaters. The engines are equipped with marine-type water-cooled manifolds. Water coming off the engine jackets thus picks up Btu's that would otherwise be exhausted to the atmosphere and wasted. Water is taken directly from discharge of the engine-compressor cooling system and circulated by the engine pump through the heating equipment.

Certain controls are necessary. There should be a control in the hook-up to keep unit-heater fans from operating until water reaches a pre-set minimum temperature. This prevents blowing cold air.

For heat dissipation in the summer months, the water can be circulated just as before, but the unit heater fans are reversed to discharge outside the building.

In a case such as this one, cost of equipment and piping necessary to recover heat and put it to work is relatively small and the scheme results in real dollar savings. The heat recovered is 1250 Btu per hour per cubic foot per minute of compressor capacity at 100 psi.



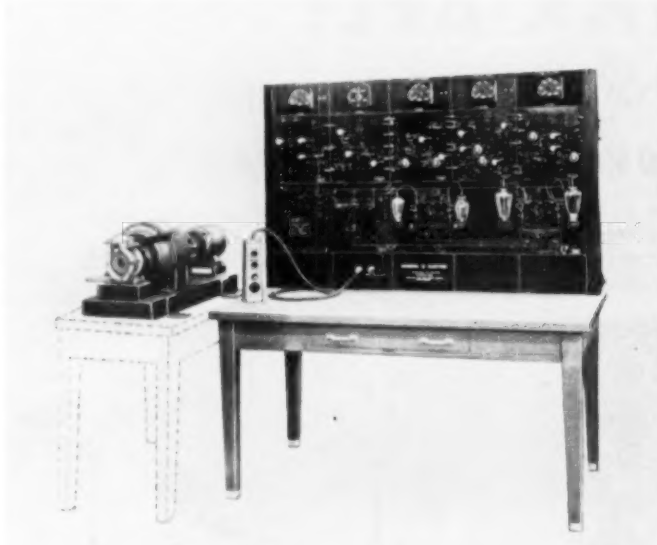
Schramm's heat recovery hook-up shows how water circulating through engine and compressor jackets, aftercoolers and manifolds, picks up heat for unit heaters

NEW FULL WAVE REVERSING EDUCATIONAL THY-MO-TROL DRIVE ANNOUNCED BY G. E.

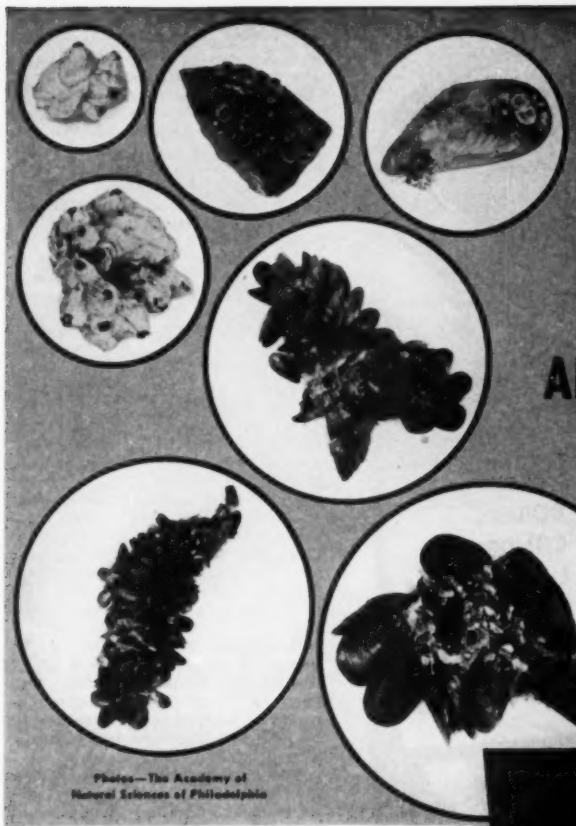
A NEW FULL WAVE reversing educational "Thy-mo-trol" drive, designed to assist in the teaching of electronic motor control and associated circuits, has been announced by the Educational Section of General Electric's Apparatus Department.

The demonstration equipment consists of 7 circuit panels and 5 instrument panels assembled on a steel frame, mounted vertically on a steel table with composition top. The circuit diagrams are molded in white into the front of the dark laminated textolite panels. The actual wiring and all components, excepting the tubes, are behind the panels, with all important circuit points brought to the front of the panel by insulated banana-plug jacks.

The Thy-mo-trol motor, tachometer generator, and manually operated brake are mounted on a common subbase for separate mounting by the school. The control station is mounted on the table, and the anode transformer is also on the table be-



Educational "Thymotrol" Drive, complete with reversing motor and manual brake assembly



A Condenser Tube is NO Home for

MYTILUS EDULIS,* ALGAE or BARNACLES

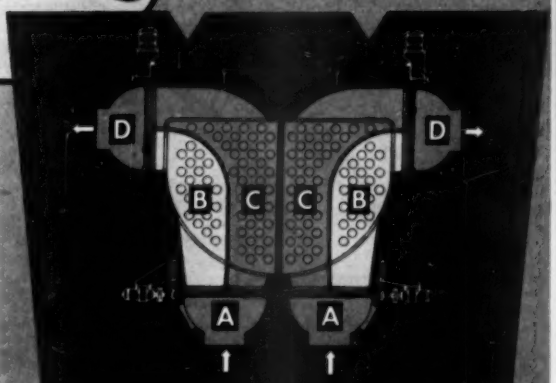
when you have C.H. Wheeler "Reverse Flow" Condensers

*Edible sea mussels

Photos—The Academy of Natural Sciences of Philadelphia

Mytilus edulis and barnacles illustrated here present a vivid picture of what they can do to condensing tubes when permitted to grow and multiply. These pests are constant troublemakers and are said to be more harmful to efficient heat transfer than any other cause of tube clogging, including algae and other fresh water organic and inorganic matter. But there's an easy, quick and economical way to rid your condenser of these sea and fresh water obstructions during operation and without loss of vacuum by using the patented C. H. W. "Reverse Flow" method. Higher temperature of the water plus the high velocity flushing action of full reverse flow successfully attacks both sea and fresh water pests, as well as any other debris that gets by screens. And you'll be surprised at the money you can save on maintenance, too. Many are now in service ranging in size from 10,000 sq. ft. up. Write for more information on how to prevent tube clogging by marine and fresh water pests with C. H. W. "Reverse Flow" Condensers.

C. H. WHEELER MANUFACTURING CO.
1802 Sedgley Avenue, Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES



In the operation of a C. H. W. "Reverse Flow" Condenser, with divided water box, water enters valve chamber at A with left hand valve part open to permit water to flow through pass B, then changing direction at other end of condenser and flowing back through pass C and out through the upper part of D. To reverse flow, valves at inlet A and discharge D are changed to permit water to flow through C first, returning through B and out through the lower part of D. Both halves of the condenser are operated in similar manner, but independently of each other.

C.H. Wheeler
SINCE 1903

STEAM CONDENSERS · WATER COOLING TOWERS
EJECTORS · STEAM JET VACUUM REFRIGERATION
OF PHILADELPHIA

CLEAN SMALL TUBES FAST

With ROTOJET Junior Tube Cleaners you can clean tubes as small as .495" I.D. quickly and economically. Very little headroom is required for either vertical or horizontal tubes. Tube bundles can be cleaned without removal from shell.

The unusual power developed by the ROTOJET Motor is due to its simple design and exclusive Rotocentric (egg-shape) bore cylinder. A shaft and a blade are the only moving parts. Positive contact between blade and cylinder is always maintained. No leakage. No stalling at low speeds. Water-driven motors are also available.

Try ROTOJET Junior, and you will never go back to heavy, slow, external type cleaners costing many times more.

in
★ BOILERS
★ CONDENSERS
★ EVAPORATORS
★ SUPERHEATERS
and other
★ TUBULAR APPARATUS

532 ROTOJET Junior Air-driven Motor, universal joint, cone cutter

C439 ROTOJET Junior Air-driven Motor, universal joint, drill head

C434 ROTOJET Junior Air-driven Motor, flexible coupling, expanding brush

C324 ROTOJET Junior Water-driven Motor, univ. joint, pivot head

SEND FOR ROTOJET JUNIOR BULLETIN

ELLIOTT COMPANY-ROTO DIVISION
147 Sussex Avenue **Newark 1, N. J.**

hind the panel. The instrument panels are across the top of the control panel assembly. This location, together with the use of long-scale instruments, makes the equipment particularly suitable for group instruction or demostration.

The control panel has been especially designed to make circuit study easy for the student. The diametric half-wave circuit used has been laid out in elementary form. Simple triodes rather than multiple tubes have been used throughout in order to make it easier for the student to analyze the various parts of the circuit. The panel operates on a 220 volt, single phase, 60-cycle, a-c line.

The motor furnished is a special 1-hp, d-c, Thy-mo-trol motor, with double shaft extension.

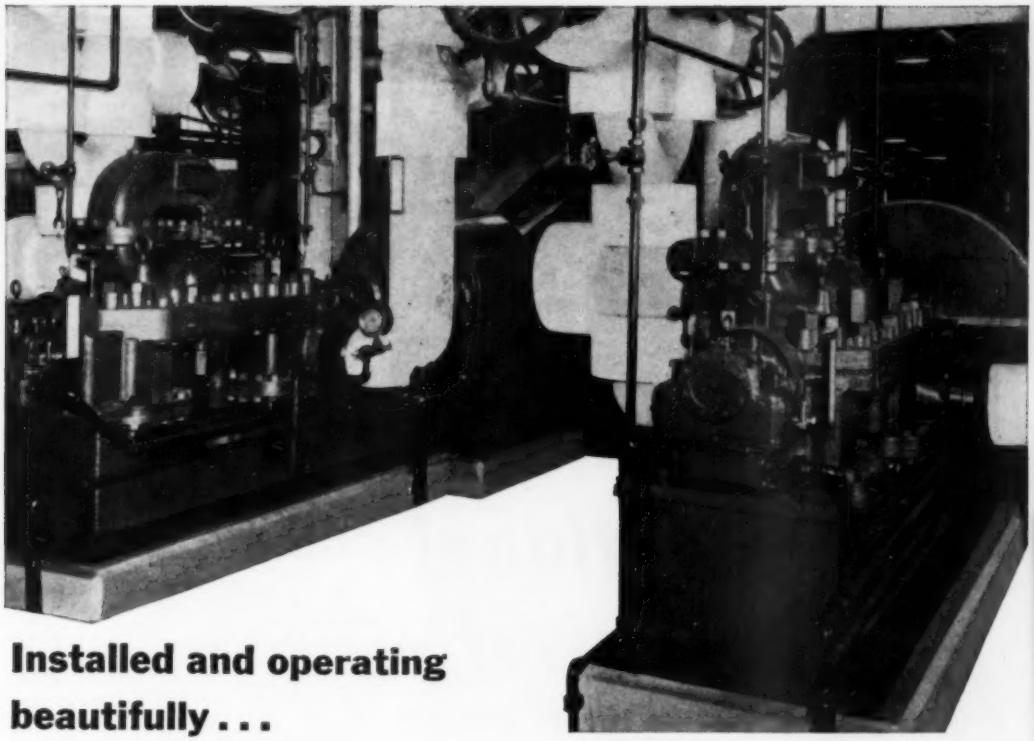
The motor with a tachometer generator mounted at one end and a manually-operated, spring release loading brake at the other is mounted on a suitable base and can be located as a unit at any convenient place for test or demonstration. The motor may be operated over the range of from 2300 to 1150 rpm by field control and from 1150 to 46 rpm by armature voltage control.

Reversing is accomplished by means of magnetic switches which reverse the motor armature connections. Thus, the d-c motor may be at its maximum rpm rating and be reversed instantly without stopping.

The circuits are so subdivided on panels that individual panels may be isolated and used for the study of fundamental portions of industrial electronic circuits. The complete unit includes the anode transformer, control station, motor assembly, and table-mounted panel.

Thy-mo-trol equipment, which has become an important tool in modern industry, provides wide-range stepless speed control of d-c motors operating from an a-c circuit while maintaining essentially constant speed with constant torque output. D. L. Chestnut, Manager of G. E. Educational Section, said, "Many graduates of technical schools will find themselves faced with the problems of designing or applying machinery operated by the Thy-mo-trol principle. It is, therefore, important that students looking forward to this phase of work be well grounded into the fundamentals of this type of equipment.

"The educational Thy-mo-trol reversing drive embodies operating principles and essential components identical with those of the standard commercial General Electric full wave reversing Thy-mo-trol drives. A student working with the educational unit, will become well grounded in standard commercial practice, but will have an unusual opportunity of working with a unit designed to assist him in a step by



Installed and operating beautifully . . .

TWO WARREN *Big Boys*

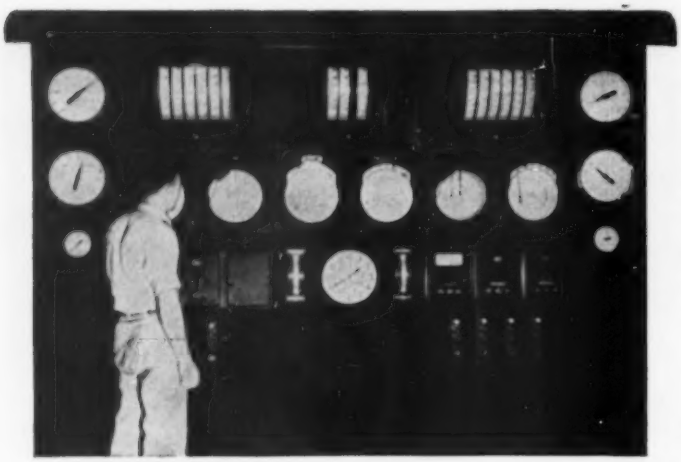
FOR CENTRAL MAINE POWER COMPANY

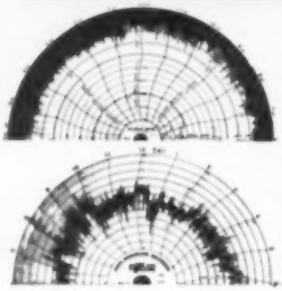
CENTRAL Maine Power Company has had many years of successful experience with Warren Pumps. Among the recent installations are two Type TH high pressure pumps at their enlarged Mason Steam Plant, Wiscasset, Maine. They are operating at capacities of 325 and 550 g.p.m. against a pressure of 900 p.s.i.g. These pumps are also available with a capacity up to 850 g.p.m. and a pressure range up to 1200 p.s.i.g. • Every construction and material feature of these Warren Pumps contribute to the highest dependability and efficiency, long life and low maintenance, with special emphasis on safety. They will prove a sound investment over the years, as numerous other Warren Pumps have in this and many other central power stations, industrial plants, municipal and Federal projects.

Write for Bulletins 241 and 244 giving complete details on Warren Pumps for higher pressure services. P-28

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC., WARREN MASSACHUSETTS





optional control—

AT THE FLIP OF A SWITCH

• Brown-Forman Distillers Corporation of Louisville wanted automatic combustion control on their three power plant boilers; but faced a problem in that one boiler is fired with coal mixed with wood waste from the cooperage plant, when available—otherwise with coal alone. The wood waste, varying from saw dust to coarse hog fuel, is not adapted to automatic control—therefore the control system must provide for easy change-over from automatic to manual operation.

• Hays operation solved this problem instantly: full automatic operation when burning coal alone—manual operation for burning wood and coal; and only a flip of a switch to change from either method to the other—no complicated linkages to disconnect, no time lost. An average of 70 percent efficiency is maintained, CO_2 averages 12 to 14 percent and the stack is clear.

• If you are seeking to improve steam plant efficiency and reduce fuel costs, look well at this truly modern system. Talk over your combustion needs with Hays engineers—good men to consult. No obligation, of course. In the meantime write for Publication 47-605—you'll find it exceedingly helpful.

THE HAYS CORPORATION • MICHIGAN CITY 7, INDIANA

HAYS Automatic COMBUSTION CONTROL

INDUSTRIAL INSTRUMENTS · INDUSTRIAL CONTROL · FLOWMETERS · GAS ANALYZERS · DRAFT GAGES · CO₂ RECORDERS

step understanding of electronic motor controls and associated circuits," he concluded.

NEWS from THE FIELD

AT THE ANNUAL MEETING of the Mutual Boiler Insurance Co. of Boston recently the members voted to change the company name to Mutual Boiler and Machinery Insurance Co.

It is expected that the new name will become effective April 1, 1950.

THE APPOINTMENT of Leon B. Wohlgemuth as sales manager of the Chicago district office of The Babcock & Wilcox Tube Co. has been announced by Edward A. Livingstone, vice president of the company. He succeeds H. J. (Skip) Lefferty who was transferred recently to Los Angeles as Pacific Coast sales manager of the Tube Company.

Mr. Wohlgemuth is a native of Bellaire, Ohio, and graduated in 1936 from the University of Pittsburgh. He has been with the B&W Tube Company since that time. In 1939 he was transferred to the Chicago office of the company and since 1946 has been assistant district sales manager at that office.

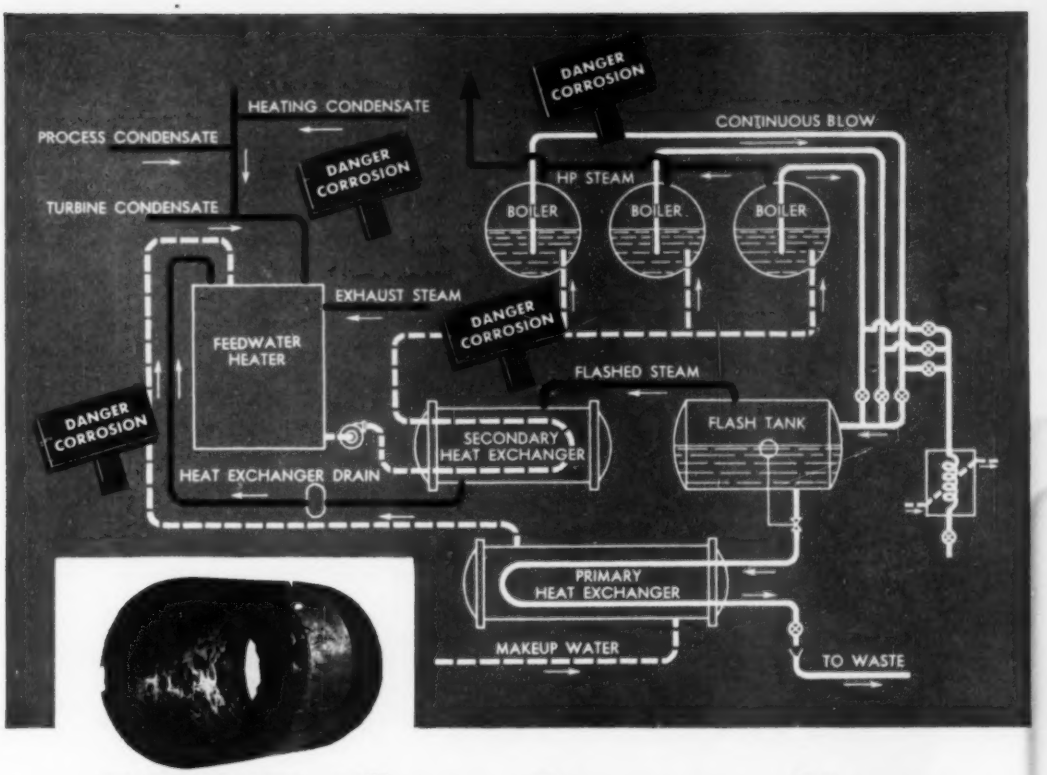
Mr. Wohlgemuth will maintain his headquarters in the Borland Building at 105 S. LaSalle Street in Chicago.

HENRY B. OATLEY, chairman of the ASME Boiler Code Committee and retired vice president of The Superheater Co. was honored with the degree of Doctor of Engineering by Stevens Institute of Technology on February 8.

An alumnus of the University of Vermont, Mr. Oatley spent his first ten years following graduation as a test engineer with the American Locomotive Company and then joined The Superheater Company which he served successively as mechanical engineer, chief engineer, vice president in charge of engineering, and subsequent to retirement from the last-mentioned position he become consulting engineer.

During these forty years he presented many technical papers before various engineering societies and railroad clubs, and has been responsible for numerous inventions relating to superheaters and other devices for lomotive use.

ELECTROCOILS, INC., newly-organized coil winding firm with factory and sales office located at Trenton, N. J., has begun manufacturing operations at its plant here. Successor to the long-established



AVOID These Danger Signs with BIRD-ARCHER Amine Treatment

CORRODED condensate return lines lead to expensive pipe replacement and maintenance. As an added annoyance, the solid products of corrosion often plug return lines and fill traps. You can steer clear of these troubles by using the *effective, economical* Bird-Archer Amine Treatment.

HERE'S THE WAY THIS B-A TREATMENT WORKS

Amines are fed into the boiler or into the steam and condensate systems. The amines raise the pH value of the condensate and also tend to inhibit equipment-destroying corrosion through surface protection of the metal itself.

HERE'S HOW THIS B-A TREATMENT SAVES MONEY

Raising the pH value of the condensate severely decreases maintenance costs by eliminating corrosion. These savings may more than offset the amount of treatment required to provide protection for your equipment.

NEW BULLETIN gives full details on the Bird-Archer Amine Treatment. . . . contains case histories that prove its successful application in many plants. *Write for your copy today.*

BA-104

WHAT AMINES ARE

Amines are members of a class of chemical compounds in which one or more hydrogen atoms of the ammonia molecule are substituted by an organic group. Some of the simpler types are soluble and volatilize from boiler waters. The alkalinity of the amines is an inherent property and does not result from decomposition. *No free ammonia is released.* In the concentrations necessary for protection of condensate systems, amines are harmless to non-ferrous metals, non-toxic and are completely stable at temperatures approximating 675F.

BIRD·ARCHER
WATER TREATMENT

THE BIRD-ARCHER COMPANY, 400 MADISON AVE., NEW YORK 17, N. Y.

Philadelphia, Pennsylvania • Chicago, Illinois • Montreal, Canada

CALDERAS Y ACCESORIOS, S. A. AMSTERDAM 291, MEXICO, D. F.

DARTS
give a snug fit
without excessive wrenching

This True Ball Joint Makes the Difference

The True Ball Joint of Dart unions are spherically-ground to form true-bearing surfaces. The reason Darts close tight . . . stay tight.

Less Expensive! You can get a snug fit easily without marring the seats of a Dart. You can uncouple them easily, too . . . use them over and over again to make important savings.

Practically Indestructible high-test, air-refined malleable iron is used for the body and nut of Dart unions. Another important feature that means longer, better service from Darts.

You'll find Darts always cost less in the long run because they give *longer service.*

E. M. DART MFG. CO.
Providence 3, Rhode Island

DART
UNIONS

Coil Winding Division of the John A. Roebling's Sons Co., whose entire production equipment it recently purchased, Electrocoils is offering a complete line of taped form wound, self contained paper section and cotton interweave solenoid coils as well as coils specifically intended for high temperature application.

L. J. Wing Mfg. Co., with three separate factories in Newark, N. J., and with general offices in New York City, has consolidated all of these in a single modern factory building at Linden, N. J. on March 3rd.

While much needed additional facilities will be provided, including extra land for future growth, the consolidation's principal purpose is to effect closer and more efficient interdepartmental co-operation.

Syntron Company, Homer City, Pa., announces the removal of their New York Sales and Engineering Office, from its old address in Long Island City to 1860 Broadway, New York 23.

Chester W. Schweers, manager of Allis-Chalmers Los Angeles district since January, 1947, has been named manager of the company's New England region with headquarters in Boston, according to an announcement by J. L. Singleton, vice-president and director of sales of the company's general machinery division. He succeeds W. F. Taylor, resigned.

The Ventilator Division of The Swartwout Co., Cleveland, now shares the company's New York City branch office at 103 Park Avenue with the company's steam specialties division, according to announcement by E. H. Bellard, ventilator sales manager. Frederick Rickmeyer has been placed in charge, filling the vacancy created by the death of Percy Jones, for many years Swartwout's New York representative. Eugene Rogers assists Mr. Rickmeyer in ventilator sales engineering.

The Magnus Chemical Co., Inc., of Garwood, New Jersey, has acquired full control of the American K.A.T. Corp., in conformity with understandings reached between the original stockholders of the American K.A.T. Corp. and officers of the Magnus Chemical Co. All functions of the American K.A.T. Corp. will continue, with the manufacture of "K.A.T." and the main office of the American K.A.T. Corporation henceforth located at Garwood, N. J.

Foster Wheeler Corp., New York, has organized a French subsidiary, Societe Foster Wheeler Francaise, for handling European construction activities. The French company will maintain offices at 6, Rond Point des Champs Elysses in Paris. R. M. Serre will direct the

For 3500 years,
ramie fiber resisted rot
in an Egyptian tomb...

Now...Johns-Manville makes ramie fiber into the rot-resistant packing...

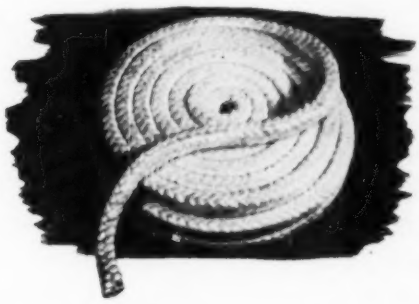
That's why *NAVALON* stands up where other packings fail!

IN PLANT AFTER PLANT, this new Johns-Manville packing made from ramie fiber is establishing new records in reciprocating service against fresh or salt water, brine, cold oil and many other liquids.

Navalon's rot-resistant properties are only one reason for these outstanding performance records. Navalon also has the high tensile strength inherent in ramie, nature's strongest fiber. An exclusive Johns-Manville process of manufacture gives it unusual lubricating properties, too—another reason for its ability to outlast other cold liquid service packings. And, in addition, Navalon is free from any tendency to score.

In the toughest service, users are finding that this unique combination of properties not only means less repacking—it means less wear on rods and plungers as well—money-saving performance all around.

Why not investigate Navalon as a means of increasing packing life and reducing costs in your plant? Get in touch with your packing distributor, or send for folder PK-32A that tells the full story. Just fill in the coupon below.



Johns-Manville
PACKINGS & GASKETS

Johns-Manville
Box 290
New York 16, N. Y.
Please send me your folder on Navalon Packing (PK-32A).

Name_____
Company_____
Address_____
City_____ State_____

PG4

sales work on the continent of Europe with headquarters at the Paris office.

THE DAMPNEY CO. of America, Hyde Park, Boston 36, Massachusetts, announces the appointment of R. E. Mundy Co., 1520 Cleveland, S.W., Roanoke, Virginia, as sales representative in Central Virginia and adjacent territory in West Virginia.

G. F. MAUGHMER has just been named manager of General Electric's new Apparatus Department sales district in the Midwest. The new district, twelfth territory in the company's nationwide sales system, will have its headquarters at St. Louis. Mr. Maughmer was formerly manager of the G-E sales office at Los Angeles.

VICE ADMIRAL EARLE W. MILLS, United States Navy (Retired), was elected president of Foster Wheeler Corp. at a meeting of the board of directors on February 27, 1950. David McCulloch, formerly vice chairman of the board, was elected chairman of the board. Harry Sanford Brown, formerly chairman of the board and president, died suddenly on February 18, while on a voyage to South America.

UNITED ENGINEERS & CONSTRUCTORS INC. has been awarded the construction of the first section of the Meramec Power Plant of Union Electric Company of Missouri. Plans and specifications will be prepared by the engineering staff of Union Electric Company and all construction will be performed under their general direction. The power plant will be located about eight miles south of St. Louis on the west bank of the Mississippi River. The initial installation is to consist of one 110,000-kilowatt high-pressure high-temperature turbogenerator and one boiler, together with all of the required appurtenant facilities.

ALLEN J. JOHNSON, formerly with Anthracite Institute, is now available as a Fuels and Combustion Consultant with headquarters at 344 Congress Ave., Landsdowne, Pa.

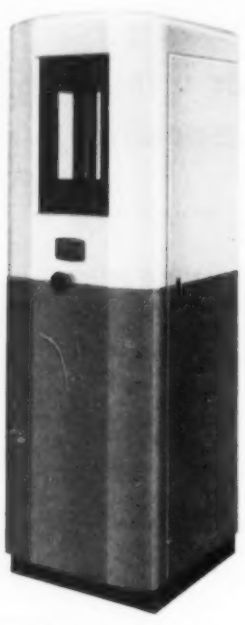
LINK-BELT CO. announces that H. Walter Regensburger has been appointed Chief Engineer of its General Engineering Department to succeed Harry L. Strube, who has retired after many years' service in sales and executive engineering capacities; and that the department has been transferred from Philadelphia to 301 West Pershing Road, Chicago.

Assisting Mr. Regensburger, will be Charles M. Young, Jr., in the capacity of Chief Developmental Engineer, and Harold F. Watson as Chief Standards Engineer. Both men have been identified with the General Engineering Department since it was first organized in Philadelphia in 1946, and both were previously members of the Philadelphia plant engineering department.

JOHN HORTH has been named manager of the St. Louis Office of the De Laval Steam Turbine Co. Operating as a direct factory branch, this office will be in a position to give industrial plants in the St. Louis area expert advice and service concerning centrifugal pumps, centrifugal blowers, steam turbines, speed reducers and other equipment.

H. H. REYNOLDS has been appointed Manager of the Los Angeles office of the De Laval Steam Turbine Co. He was located in the Home Office of the De Laval Steam Turbine for many years.

J. S. MORGAN, engineer-in-charge of sales for the switchgear and control sections of Allis-Chalmers' electrical department since 1947, has been named manager of the switchgear section, according to an announcement by R. M. Casper, manager of the electrical department.



Before it Strangles Your Condensers

Keep condenser and heat exchanger tubes clean, clear, and slime-free by chlorinating cooling water with *Builders Chlorinizers*. Accurate, safe, and simple to operate, these chlorine gas feeders bring new economy and efficiency to your power plant operation. They are readily adapted to your particular requirements . . . may be operated manually or by semi-automatic or fully-automatic methods. Remember, when it's *Builders* it's backed by a Company (established in 1820) that has specialized in flow metering and controlling equipment for more than 55 years. For engineering information and descriptive Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), Providence 1, R. I.

BUILDERS *Chlorinizers*

The chlorine gas feeders with extra features

BUILDERS PRODUCTS

Flow Meters and Controllers . . . Mechanical and Differential . . . For Liquids, Steam, Air, and Dry Materials • The Venturi Meter • Chlorinizers — Chlorine Gas Feeders

BUILDERS PROVIDENCE *Instruments*

BRINGING YOUR
COAL HANDLING COSTS

Down to Earth

Concrete Silo Storage with live storage shelf, track hopper, double-chain bar feeder, centrifugal discharge bucket elevator, scale and monorail bucket.

Tile Silo Storage with track hopper, bar feeder, bucket elevator, 2000 lb. weigh larry.

Cylindrical Steel Tank Storage with feeder and conveyor.

Suspended Steel Bunker Storage showing bunker and weigh larry.

When coal handling costs are too high for comfort, remember Gifford-Wood's 4-basic design story. Each of these storage designs—concrete silo, tile silo, cylindrical steel tank and suspended steel bunker—are carefully engineered to meet specific limitations of climate, capacity, space available and cost. The combination of extensive engineering experience and well known manufacturing ability assures installations of highest possible operating efficiency at reasonable cost.

A Gifford-Wood engineer, thoroughly familiar with coal handling problems, is at your service. Let him study your needs and recommend a G-W system that will both simplify the operation and reduce your costs.

4

BASIC G-W WAYS TO CUT COAL HANDLING COSTS

1. Reinforced Concrete Silo Storage
2. Vitrified Tile Silo Storage
3. Cylindrical Steel Tank Storage
4. Suspended Steel Bunker Storage

Bulletin No. 300 describes, with illustration and working drawing, these 4 basic G-W types of handling systems. Write today for your copy.

GIFFORD-WOOD CO.

SINCE 1814
Hudson, N. Y.

NEW YORK 17
420 LEXINGTON AVENUE

CHICAGO 6
565 W. WASHINGTON STREET

ST. LOUIS 1
RAILWAY EXCHANGE BUILDING

6378

G-W HANDLES IT . . . faster • easier • cheaper

Obituaries

HARRY SANFORD BROWN

HARRY SANFORD BROWN, president and chairman of the board of Foster Wheeler Corp., New York, died suddenly February 18 following a heart attack aboard a liner en route to Rio de Janeiro.

Brown managed the Boston office of Power Specialty Co. from 1904 until 1918, when he left to become vice president of Wheeler Condenser & Engineering Co. When the two companies were consolidated to form Foster Wheeler in 1927 he was made vice president and a director. He was elected president in 1935 and chairman of the board in 1946.

JACOB T. BARRON

JACOB T. BARRON, Vice President in charge of Combined Operations and a director of Public Service Electric and Gas Co., died March 12 in Alexian Brothers Hospital, Elizabeth, N. J., after a month's illness. He was 65.

After being graduated from the University of South Carolina in 1905 with a bachelor of science degree, Mr. Barron took a position in the Testing Department at the Schenectady Works of the General Electric Co.

In September, 1907, Mr. Barron came to Public Service. From October 15, 1907 to February 1, 1908, he was connected with the construction department as inspector of steam turbine installation. He was successively made chief operator of substations and generating stations in the company's Central Division; general superintendent of generation, and had charge of all electric power generation in Public Service; general manager, Electric Department; Vice President in charge of Electric Operation and a director of Public Service Electric and Gas Co. On January 20, 1948, he was promoted to Vice President in charge of Combined Operations.

CORNELIUS W. DeFOREST

CORNELIUS W. DEFOREST, widely-known authority in the electrical-utility field and consultant to the Economic Co-Operation Administration of the U. S. Government, died in Washington, D. C. Nov. 17, 1949. He was born in Brooklyn, N. Y., Sept. 19, 1878; parents, David William and Sophia Chase (Morrow) DeForest. He received his education in evening classes, Columbia University. He became a member of ASME in 1922.

FRANCIS HODGKINSON

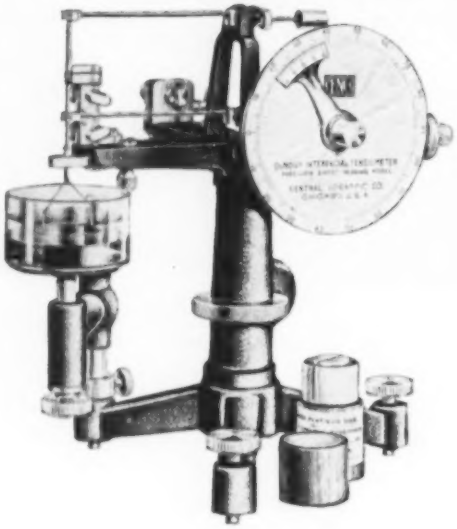
FRANCIS HODGKINSON, mechanical engineer and inventor who held 101 patents, principally on steam turbines, died Nov. 4, 1949, in St. Vincent's Hospital, Toledo, Ohio, after a long illness. He was retired as consulting mechanical engineer, Westinghouse Electric and Manufacturing Co. in 1936, after forty years of service for that company.

He was born in London, England, June 16, 1867, parents, Francis Otter and Margaret (Thompson) Hodgkinson. He received his education at Royal Naval School, New Cross, England; Armstrong College, Newcastle, England; married Edith M. K. Piercy in 1897.

He was honorary professor, mechanical engineering, Columbia University. He had been awarded Louisiana Purchase Exposition Silver Medal, 1904; Elliott Cresson Gold Medal, The Franklin Institute, 1925; honorary degree of mechanical engineering, Stevens Institute of Technology, 1935; Holley Medal, ASME, 1938.

He was a member of ASME, 1902; Fellow ASME, 1939; Hon. Mem. ASME, 1947, served as vice-president, ASME, 1939-1941; chairman, Committee on Power Test Codes, 1937; member AIEE, Engineering Society of Western Pennsylvania, The Institution of Mechanical Engineers.

THE CENCO
du NOUY INTERFACIAL TENSIOMETER



Interfacial and surface tension measurements are extremely important in the testing and control of transformer, lubricating and Diesel engine oils. For example, in testing transformer oil, the tensiometer readings indicate the sludge condition or breakdown point of the oil. This test eliminates costly burn out of transformers and saves on replacement oil.

The Cenco du Nouy Interfacial Tensiometer complies with the requirements of ASTM Method D971-48T, Interfacial Tension of Oil Against Water by the Ring Method.

No. 70540 CENCO du NOUY INTERFACIAL TENSIOMETER, $302.50

Write for detailed information

CENTRAL SCIENTIFIC COMPANY
Scientific CENCO Apparatus
1700 IRVING PARK ROAD CHICAGO 13
NEW YORK BOSTON SAN FRANCISCO NEWARK LOS ANGELES TORONTO MONTREAL

NEW

Latest Developments in HOT-PROCESS SOFTENERS

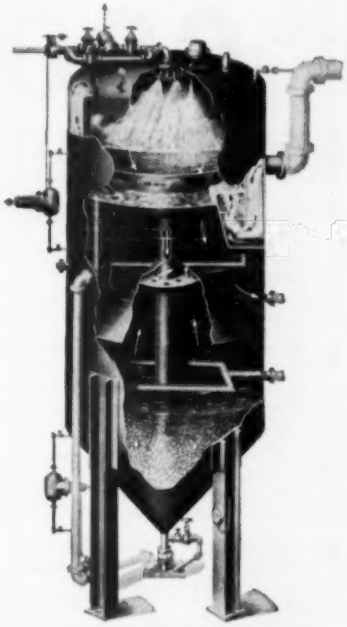
Described in this 36-page bulletin

Here is a bulletin that should be read by every plant executive and engineer with boiler feed problems.

It is *authoritative* because it is prepared by the engineers and chemists of an organization with more than *40 years of experience* in the field of hot process treatment and general boiler feedwater treatment.

It is *informative* because it clearly shows the practical applications of the scientific principles involved in modern, efficient hot process softener designs.

Copies of the bulletin will be sent without charge to plant executives and engineers writing on their Company letterhead.



SOME OF THE SUBJECTS COVERED

Operating problems requiring boiler feedwater treatment

The 12 principal methods of feedwater treatment

Why the hot-process treatment is widely used

Chemistry of the hot-process treatment

Basic principles and requirements of modern hot-process softener design

How a GRAVER Hot-Process Softener operates

16 Designs of modern hot-process softeners and where each should be used

Hot Zeolite Softening

Latest developments in chemical feeders and their accessories

Results obtained from hot-process softeners in various types of installations

GW 430

GRAVER

GRAVER WATER CONDITIONING CO.

Dept. 104, 216 West 14th Street, New York 11, New York, U.S.A.

A DIVISION OF GRAVER TANK & MFG. CO. INC. EAST CHICAGO, IND.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 **Working Pressure Data Card**—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table. Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart covers 2 letter-size pages, is printed on firm stock, and punched for use in binder. The Babcock & Wilcox Tube Co.

202 **Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

203 **Water Tube Boilers**—This 12-pp bulletin illustrates and describes special and standard power plant boilers and packaged steam generators. Includes data and dimensions. Springfield Boiler Co.

VALVES, TRAPS, PIPING

204 **Pipe Distribution System Data** — "Engineering Distribution Data for Underground Steam Distribution," is the title of Section 480-2, 34 pp, of practical usefulness to those who deal with problems involved in insulated piping distribution systems. It covers layout of the route and methods of estimating steam loads, includes steam flow charts and tables, and gives properties of steel pipe, copper water tube piping and saturated steam. Also gives specifications of steam and hot water distribution piping with prefabricated pipe conduit. It's illustrated with photos of field installations and industrial applications of insulated pipe units, also sketches showing method of making field closures. The Ric-Wil Co.

205 **Piping Materials Catalog**—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320, 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

206 **Steam and Water Mixer** — Bulletin 900-A describes company's steam and water mixer for providing hot water at isolated points. An explanation of how the mixer works accompanies a large, cutaway illustration. Includes dimensional data, sizes, capacities and prices of mixer and spare parts, also photo and sketch showing typical installations. Sarco Co., Inc.

207 **Pipe Hanger Catalog** — Ninety-page Catalog 10-D is a valuable buyer's guide for adjustable pipe hangers and supports. Covers hangers for attachments to pipe and to structure, hanger assemblies, spring hangers, hanger rods, pipe supports and related equipment. Each type described and illustrated by photo and dimensional diagram and listed with dimensions and prices. Catalog also includes standard specifications, photos of installations and terms of sale. Indexed for quick reference; punched for filing in binder. Grinnell Co., Inc.

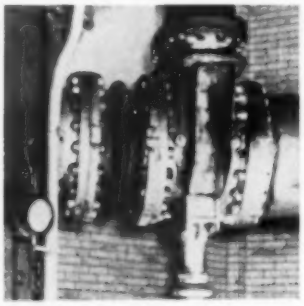
208 **Valves Bulletin**—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk or plug, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented. Edward Valves, Inc.

209 **Rubber Expansion Joints** — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The bulletin is well illustrated. The Garlock Packing Company.

210 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

211 **Flanges for Severe Service** — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid-

Check The Advantages Found Only in GOODALL EXPANSION JOINTS WITH "FLANG-LOK" FLOATING FLANGES

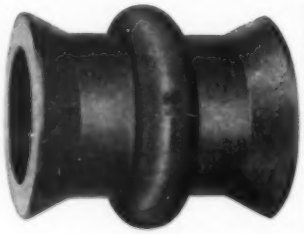


1- **Quickly, easily installed.** Split flange accommodates flared end of joint. Turn flange only (not joint or pipe) to align bolt holes with fixed connecting flange.

2- **Leakproof, rubber-cushioned seal.** As bolts are tightened, rubber end of joint is compressed over broad area against connecting pipe. Magnitude of forces forming seal is in direct proportion to stress applied to bolts.

3- **Superior strength, durability, safety.** Special built-up construction, employing rubber, duck and metal, assures widest margin of safety against rated pressures.

4- **Plain, efficient operating principle.** All movement occurs in center corrugation. Width of corrugation determined by extent of movement required.



For all standard pipe sizes from 1/8" to 96" I.D., on lines carrying fluids and gases under vacuum or pressure, at temperatures up to 250°F. **Phone our nearest branch for further details, or write for illustrated folder.**

GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles · San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities

Est. 1870

and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

211A **Steam Traps**—Catalog 448, 32 pp, provides dimensional, application and engineering data on company's line of steam traps. Includes prices and weights and ordering information and is generously illustrated. Covers industrial steam traps, expansion steam traps, weight-operated and piston-operated types, continuous flow gasoline trap, separators and related equipment. W. H. Nicholson & Co.

HEATERS, HEATING

212 **Fan Heater Bulletin**—Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. One page is devoted to description and photos of the heater. Other page contains a sketch in color showing how the heater works. Niagara Blower Co.

213 **Packaged Heat**—Unit heaters featuring low first cost, easy installation and continued low cost per Btu are presented in this 12-pp booklet. Text explains how these packaged heaters are designed to operate instantly on oil or gas, fit heat output to requirements of day, and provide heat where it's wanted. Illustrations include photos of heaters and several installations and many sketches showing advantages and construction details. Pratt-Daniel Corp.

214 **Tubular Heat Exchangers**—Bulletin 916, 32 pp, is highly informative. The bulletin describes the present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

215 **Chemical Soot Removal** — Ten-pp Bulletin 43, on the chemical removal of soot from boiler furnaces, explains the research work that led to the development of manufacturer's new chemical soot remover and slag alleviator for coal fired boiler furnaces. It tells how this combustion catalyst prevents soot formation on furnace internals and helps to end the smoke problem. National Aluminate Corp.

216 **Water Heaters**—Illustrated 8-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

217 **Tubular Heater**—A simplified vertical tubular heater suitable for every process duty and designed to hold initial and maintenance costs to a minimum, is the subject of 4-pp Bulletin 0-49-7. Includes a complete description of this simplified design which features the use of bare tubes and the absence of any metal parts exposed to furnace gases, also a discussion of the design's advantages. Cutaway drawings illustrate text. Foster Wheeler Corp.

218 **Condensate Drainage Control** — Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3250. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 25 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit tabulated for unit inlet pressures. Illustrations include photographs and dimensional drawings in color showing design and construction of both types of units. Cochrane Corp.

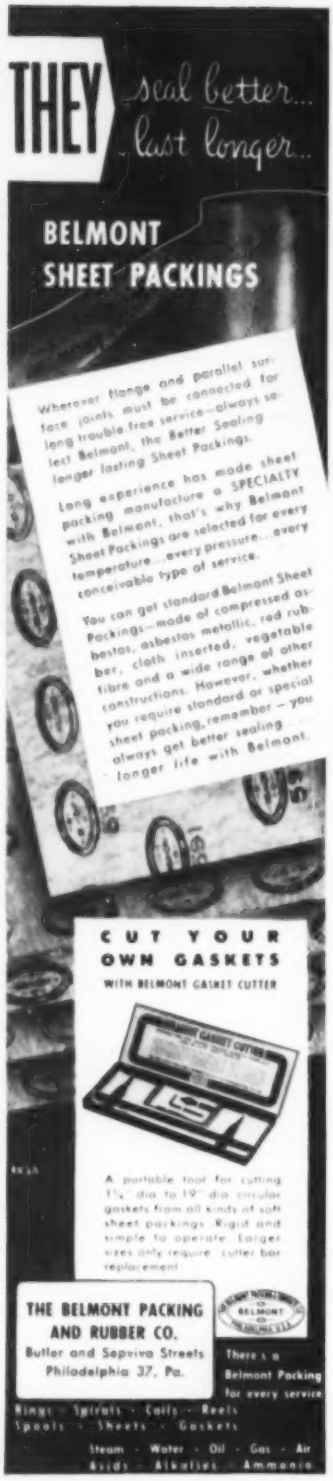
No instrumentation is really complete unless an automatic coal scale is an integral part of it. Only then can you have a minute-by-minute record of every pound of coal consumed per boiler.

RICHARDSON AUTOMATIC COAL SCALES give you this fully accurate record, automatically—hour by hour, shift by shift, week by week. Result: you spot instantly any coal-wasting boiler or other operating inefficiency... *keep power production costs at the minimum, power production itself at the peak.*

Coal is your biggest single item of expense. Be sure you're getting full capacity in b.t.u. and kw.-hr. from every boiler or turbine in your plant. Get all the facts on the economy, dependability and proven efficiency of RICHARDSON AUTOMATIC COAL SCALES. Write today for Bulletin 1143. It shows you how you can take a long step forward toward minimum coal costs... maximum power production.

RICHARDSON SCALE COMPANY
CLIFTON, N. J.
Atlanta • Boston • Buffalo
Chicago • Omaha • New York
Pittsburgh • San Francisco
Philadelphia • Minneapolis
Wichita • Montreal • Toronto

6310


THEY seal better... last longer...
BELMONT SHEET PACKINGS
Wherever flange and parallel surface joints must be connected for long trouble free service—always select Belmont, the Better Sealing longer lasting Sheet Packings.
Long experience has made sheet packing manufacture a SPECIALTY with Belmont, that's why Belmont Sheet Packings are selected for every temperature...every pressure...every conceivable type of service.
You can get standard Belmont Sheet Packings—made of compressed asbestos, asbestos metallic, red rubber, cloth inserted, vegetable fibre and a wide range of other constructions. However, whether you require standard or special sheet packing, remember—you always get better sealing longer life with Belmont.
CUT YOUR OWN GASKETS
WITH BELMONT GASKET CUTTER
A portable tool for cutting 1¼" dia. to 19" dia. circular gaskets from all kinds of soft sheet packings. Rigid and simple to operate. Larger sizes only require cutter bar replacement.
THE BELMONT PACKING AND RUBBER CO.
Butler and Sepviva Streets
Philadelphia 37, Pa.
There's a Belmont Packing for every service
Rings · Spirals · Coils · Reels
Spools · Sheets · Gaskets
Steam · Water · Oil · Gas · Air
Acids · Alkalies · Ammonia

TREATMENTS, PREVENTIVES

219 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also discusses special purpose chemicals. Wright Chemical Corp.

220 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 6-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

221 **Corrosion Resistance of Nickel Alloys**—Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 66 tables and 33 graphs and photos in addition to text. Problems involving a wide range of operations from the pickling of steel to petroleum refining and textile processing are covered. The International Nickel Co., Inc.

222 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

223 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

224 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

225 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin 2EB7030. Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

226 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. Illustrations include photographs of two feeders and diagrams of the various methods described. Punched for filing in ring binder. Proportioneers, Inc.

227 **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

228 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures. The Bird-Archer Co.

229 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps and a typical packaged installation. Milton Roy Co.

ELECTRICAL

230 **Large D-C Motors**—Latest construction features of manufacturer's large d-c motors for applications requiring wide speed variation and fine speed control are discussed in 40-pp Bulletin OB58002A. Included is a comprehensive description of "frog leg" armature windings, a combination wave and lap winding that gives good commutation without cross-connectors and views of the new style mill-type spherical seated thrust bearing with welded-steel pedestal for heavy service. Controls for the motors, currently being used to drive metal rolling equipment, mine hoists, paper machines, rubber mill rolls, plastic calenders and traction equipment are also covered. Allis-Chalmers Mfg. Co.

231 **Synchronous Generators**—This Bulletin, 05B6139A, describes construction features and electrical characteristics of engine-type synchronous generators in standard ratings from 25 to 10,000 kva and for standard speeds from 100 to 600 rpm, for Diesel, steam or gas engines. Also describes and illustrates mechanical construction of stators and rotors and discusses machine characteristics, ratings, voltages, frequencies, phases, temperature rises and operation at high elevation. Illustrations show typical installations. Available control accessories are listed, as are manufacturer's other products and territorial sales offices. Allis-Chalmers Manufacturing Co.

232 **Synchronous Motors** — High speed synchronous motors are described in this recently-issued 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

PUMPS, COMPRESSORS, ENGINES

233 **Rotary Pumps**—Catalog LG, 4 pp, provides cutaway drawings and description of six different types of company's "TMO" rotary pumps, designed to handle residual and distillate fuel oils, crude oils, lubricating oils, viscous fluids and similar liquids. Discusses reliability, high speeds freedom from pulsation, accessibility and other advantages of these pumps in capacities ranging from 0.5 to 1000 gpm for pressures to 500 psi, and to 150 gpm for pressures to 1500 psi. DeLaval Steam Turbine Co.

234 **Steam Engine Governor Data**—This new bulletin No. 502, describes the company's Type EN fully enclosed self-lubricated governor which is described as giving "precise, dependable engine speed control." Illustrations of the unit are presented and a parts list, accompanied by a sectional diagram is given. One section "Installation and Care" tells how to assemble governor to engine cylinder and how pulleys should be proportioned, the proper type of belt for use with the gov-

How do your employees WANT to invest their savings?

People are *more than twice as inclined* to invest their extra money in Savings Bonds as in any other form of savings or investment, according to the 1949 Survey of Consumer Finances*. That's adequate proof that your employees want your company to have the Payroll Savings Plan, by which they get the convenience of obtaining bonds regularly and "automatically"— delivered with their pay checks.

More than 20,000 companies operate Payroll Savings. The managements of these companies know it's "good relations" to provide this convenience. They can *see* the company-benefits in improved worker efficiency and stability. They know, too, that it's "good business"—because Payroll Savings boosts Bond sales, and Bond sales create a huge backlog of purchasing power that's "business insurance" for the years ahead.

Of course every Bond buyer builds financial independence because his Bonds at maturity will return $4 for every $3 he invests. Holding Bonds, moreover, helps him to realize he's making a profit on his job . . . makes him more resistant to influences which are unfavorable to our economic system.

It's easy to install Payroll Savings

Don't think that installing Payroll Savings is "a lot of work." All you need to do is appoint one of your top executives as Savings Bonds Officer and tell him to get in touch with your State Director, Savings Bonds Division, U. S. Treasury Department. The State Director will provide application cards, promotional material, and as much personal help as necessary. Remember—Payroll Savings *pays!*

**Sponsored by the Board of Governors of the Federal Reserve System and conducted by the University of Michigan. Based on 3,500 interviews in 66 sampling areas throughout the nation.*

The Treasury Department acknowledges with appreciation the publication of this message by

Power Generation

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and The Advertising Council.

TEST WATER HARDNESS

this SIMPLE, FAST, ACCURATE way

TAYLOR TOTAL HARDNESS SET

This new Taylor Set replaces the slow, inconvenient soap test. Make fast, accurate determinations on waters ranging in hardness from 1 to 1400 p.p.m. . . . ideal for checking boiler water or as a control test on zeolite or lime-soda treated waters.

HERE'S HOW SIMPLE A WATER HARDNESS TEST CAN BE . . .

You simply place a 50 cc. sample of the water to be tested in a 250 cc. flask with 2 drops of Taylor Hardness Indicator and 1 cc. of Taylor Hardness Buffer. At this point the sample will be red. Add Taylor Hardness Reagent from a burette until the red color changes sharply to blue. Multiply the burette reading in cc. by **20** and . . .

There's the Value!

Write For Complete Information

Each Taylor Total Hardness Tester is sold complete . . . includes all necessary equipment and reagents. Write direct for prices and additional information. Also ask for the Taylor Handbook, "Modern pH and Chlorine Control."

W. A. TAYLOR AND CO.
7101 YORK RD • BALTIMORE 4, MD.

ernor, correct lubrication procedure, method of packing and other data. Troy Engine & Machine Co.

235 **Condensers**—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

236 **Compressor Selection Chart**—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

237 **Air Compressor Lubrication Manual**—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated with large, clear photographs and drawings showing construction and operation of compressors, their lubricating systems, etc. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

238 **Steam Pumps** — This is manufacturer's collection of bulletins covering all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

INSTRUMENTS AND CONTROLS

239 **Smoke Density Recorder** — Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

240 **Boiler Water Level Control** — Bulletin 487 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. A large, full-page cross section of the B & W Type FH integral furnace boiler is presented and other drawings and photographs show the accompanying equipment. Northern Equipment Company.

241 **Water Gages** — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-2, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

242 **Temperature Measuring Instruments**—For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

243 **Recording Instrument Data Book**—An oxygen-analyzer, based on the para-magnetic property of oxygen, is described and illustrated in Bulletin 49-829, 16 pp. Tells advantages and applications of the instrument; also discusses manufacturer's analyzer for carbon dioxide and other gases and an electronic recorder

The
MAINTENANCE DEPARTMENT
of
CONDENSER SERVICE & ENGINEERING CO., INC.
100 RIVER ST., HOBOKEN, N. J.
Offers to do
QUICK—PROMPT
RETUBING SERVICE
on BOILERS — CONDENSERS
HEAT EXCHANGERS
ANYTHING WITH TUBES
24 HOURS A DAY — 7 DAYS A WEEK
365 DAYS A YEAR
SATURDAYS - SUNDAYS
HOLIDAYS
WE CARRY TUBES IN STOCK
CALL — TELEPHONE: Day and Night
NEW YORK: REctor 2-9363
HOBOKEN: HOboken 3-4428
St. Paul, Minn.:
Day—Nestor 9675 - Night—Emerson 3219
Chicago, Ill.:
Day—STate 2-1415 - Night—SHeldrake 3-4735
Boston Mass.:
Day—LAfayette 3-1091 - Night—MYstic 6-4552
Tulsa, Okla.:
Day—Tulsa 5-7717 - Night—Tulsa 4-4060
Phila, Pa.: Day—Wilmington (Del.) 7151
Night—Chester (Pa.) 2-4576
Baltimore, Md.: SAratoga 5285
Atlanta, Ga. Dearborn 4477
Washington, D. C.: Republic 4875
Los Angeles, Cal.: TRinity 7861

CLASSIFIED ADVERTISING

POSITION WANTED

STEAM ENGINEER, desires position with growing concern or utility now staffing new Power Plant or seeking replacement. Unusually strong practical and technical background for a young engineer. Successful administrative capacities in three different types of basic industrial Power Plants. 30 years of age. Married. Address Box 1643, POWER GENERATION, 53 W. Jackson Blvd., Chicago 4, Ill.

HELP WANTED

WANTED
MECHANICAL ENGINEER

Established consulting firm New York Area, desires Mechanical Engineer, capable supervisors starting, testing operating and correcting troubles of steam-electric station equipment. Plant betterment work involving considerable traveling. Technical education, and plant operating or betterment experience required. State education, experience and salary desired.

Box 1642
Power Generation
53 W. Jackson Blvd. Chicago 4, Ill.

EQUIPMENT FOR SALE

TRANSFORMERS

3—General Electric, Single Phase, Type "HS", Form WD Transformers, Voltage 13,200—2,400/4160 Y, K.V.A. 333, 60 Cycles, Subtractive Polarity, 55° Centigrade Temperature Rise, Total Weight each approximately 4,175 lbs. **THE GLENN L. MARTIN COMPANY, Baltimore 3, Maryland. Att.: Mr. Jan Porel.**

(temperature and pressure) for use with analyzers. Describes several recommended gas sampling systems. The Hays Corp.

244 **Metering Chlorine** — Bulletin 640-P2 describes an instrument designed to accurately meter chlorine gas and deliver a chlorine water solution to the point of application. Discusses the safety and other features of the instrument and explains its operation and maintenance. Illustrations include photos, a phantom drawing showing principle working parts, and a layout diagram. Builders-Providence, Inc.

245 **Purity Indicator**—An instrument for measuring and indicating electrical conductance of steam and water is described and illustrated in 6-pp Bulletin 11-23-48 RCU. It discusses problems encountered with steam and condensate purity and cites examples of how controller and alarm assembly are utilized in detecting and signalling impurities caused by carry-over and condenser leakage. Includes photos of typical test apparatus, also prices. E. F. Drew & Co., Inc.

COAL HANDLING

246 **Screw Conveyor**—Two-pp Form A-84 describes a high-speed, direct-feed, bin-to-stoker screw conveyor that comes ready to set up. Illustrations show this conveyor in use and detail of its principal parts. Stresses economy of this conveyor in handling coal and includes specifications. Baughman Mfg. Co., Inc.

247 **Coal Scale Data Book**—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

248 **Spreader Stoker Selection** — Fourteen-pp Form F-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

249 **Coal Crushing, Sizing** — Bulletin 3007 describes the company's Bradford breaker a coal crusher, sizer and scavenger. The bulletin presents drawings of the breaker, tells how it works and then presents the complete story of its operation at the coal mine and coal cleaning plant at the By-Product Coke Plant and at the Power Station. The back section of the catalog presents engineering information on capacities, dimensions and dimensioned line drawings. Pennsylvania Crusher Co.

250 **Coal Crusher**—In this 8-pp bulletin a rolling ring crusher is presented as a solution to the problem of uniform stoker coal. Describes the special features of this crusher, emphasizing its shredder designed to split coal rather than crush it. Gives speed, capacity, weight and dimensions of available models and illustrates principle of operation. Also contains photos of parts and several complete installations. American Pulverizer Co.

251 **Underfeed Stokers**—Bulletin 350, 24 pp, features a single retort underfeed stoker which may be operated by electric or steam drive. It is described as a complete firing unit for burning various grades of bituminous coal with high efficiency for boilers from 50 to 150 hp rated capacities. Generously illustrated, the bulletin explains the operation of these stokers, tells their applications and economy and gives sizes and capacities. Also contains installation photos and diagrams. Detroit Stoker Co.

252 **Coal Handling Equipment** — Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Also describes and illustrates a skip hoist and other auxiliary equipment. Gifford-Wood Co.

BOILER TUBES

Bent or STRAIGHT

FOR ALL TYPES OF BOILERS

ALSO CONDENSER, HEAT EXCHANGER AND AIR HEATER TUBES IN CARBON AND ALLOY STEELS

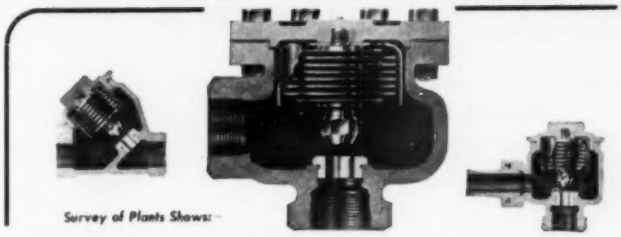
Write or wire us today about your particular tubing needs.

Pipe & Tubular Products

INCORPORATED

2610 W. DAUPHIN STREET

PHILADELPHIA 32, PA.

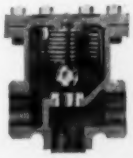


Survey of Plants Shows:

15 of 20 Engineers Prefer Nicholson Traps

To determine the best steam trap on which to standardize, a large processing firm recently asked their plant engineers for their preference. In 15 out of 20 plants the choice was Nicholson.

The repeated adoption of Nicholson steam traps in plants currently in big "cost-reduction-through-modernization" programs is another indication of their advanced features. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic steam traps send for our catalog. 5 types for every power, heat, process use; size ¼" to 2"; press. to 225 lbs.



Catalog 448 or see Sweet's

W. H. NICHOLSON & CO. 160 OREGON STREET WILKES-BARRE, PA.

Control Scale and Corrosion

in BOILERS, WATER JACKETS, CONDENSERS

--Wherever Water is Used

Wright CHEMICALS

Increase the efficiency and life of vital plant equipment by using WRIGHT Water-Conditioning Chemicals.

Write for helpful information.

WRIGHT CHEMICAL CORPORATION

Specializing in Water Conditioning

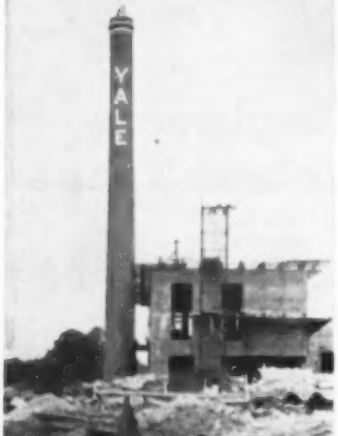
GENERAL OFFICE AND LABORATORY 619 West Lake Street, Chicago 6, Illinois

OFFICES IN PRINCIPAL CITIES

Sole Distributor of Nalson Chemical Proportioning Pumps

Consult Us For:

CHIMNEYS . . .
FURNACE WORK . . .
BOILER SETTINGS



AMERICAN CHIMNEY CORP.

141 Fourth Ave., New York 3, N. Y.

BRANCHES:

BOSTON • PHILADELPHIA • CLEVELAND

DETROIT • PITTSBURGH • CHARLOTTE

DE LAVAL-IMO PUMPS

SIMPLE . . . RELIABLE . . .
EASY TO TAKE APART

Only three moving parts. No pilot gears. No sliding vanes. No reciprocating members. Nothing to get out of order.

IMO Pumps are designed for handling oils, hydraulic control fluids and other liquids over a wide viscosity range.

Send for Catalog L-32A G

IMO PUMP DIVISION of the
DE LAVAL STEAM TURBINE CO.
TRENTON 2, NEW JERSEY

TURBINES

253 **Turbine Catalog Collection**—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

254 **Velocity Stage Turbines** — Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts. Speed governor and regulating valve, and emergency governor and trip valve are described in detail. De Laval Steam Turbine Co.

255 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

MISCELLANEOUS

256 **Pump Packings**—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

257 **Concrete Floors Q & A** — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. A section on placing and finishing corrosion resistant floors will be helpful to prospective users. Lumnite Division, Universal Atlas Cement Company.

258 **Tube-Ice Machine** — Bulletin TI-3 describes manufacturer's automatic ice-making machine for producing either cylinder or crushed ice. Explains and illustrates machine's operation, discussing its small space requirement, quick freezing time, reduced power consumption and economy. Its application in the dairy and packing industries, breweries, chemical plants, institutions, and ice plants are described and pictured. Also discussed is the utilization of this machine in cold water refrigeration for air conditioning systems. Includes chapter on the handling and storage of ice. Henry Vogt Machine Co.

259 **Purger Bulletin**—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

260 **Water Hardness Test**—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

261 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1428, 36 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements and recommending equipment for the job. American Blower Corp.

Mr. Businessman!

WHAT WILL THE 1950 CENSUS DO FOR YOUR BUSINESS?

CONSUMER MARKET INFORMATION

The 1950 Census will provide a huge amount of information about the characteristics of the consumer market. It will tell you what kind of income groups live where . . . what they have and what they need in the way of commodities from automobiles to television sets down to plumbing fixtures. The Census is an accurate survey of economic conditions in your market area. It will not only tell you *where* your customers are, but *what they need that you have to sell them!*

It will show where improved transportation and shipping facilities are needed . . . better harbors and waterways . . . stepped-up Public Service.

That is why the 1950 United States Census is vital to your business!

COOPERATION

You know that the Census-Taker is not just "counting heads." He's actually making a survey of existing conditions in industry, business, employment, housing, education. *You* know census information is as confidential as the vote you cast! Because you know all these things *you'll* cooperate with the Census-Taker in every way when he calls on you.

WHAT ABOUT THE OTHER FELLOW?

But! What about the people who work for you? The man in the shop . . . your own secretary . . . the fellows in the shipping room. Do they know all this about the Census? Chances are some of them do, so the idea is to get the right information across to those who don't!

WHAT'S THE BEST WAY?

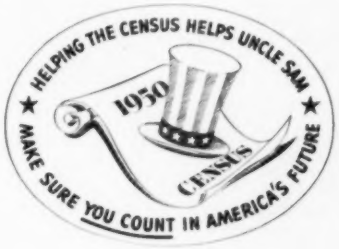
If it's possible, call everyone together and talk about it . . . ask questions . . . exchange ideas. If your outfit is too big for that, direct a Census information memorandum to all your employees. Post information on the bulletin boards. Run a Census story in the company house organ. Talk about it. *Every way you can . . . get the people who work for you to cooperate with the Census.*

WHAT DOES THE 1950 CENSUS MEAN TO YOUR EMPLOYEES?

Better schools . . . school buses . . . school lunches. It means finer roads, bridges and highways . . . increased transportation facilities . . . improved safety regulations. It creates more efficient Public Service and furthers adequate distribution of utility services such as telephones, gas, water and electric power. It will help your community plan better parks, playgrounds, recreation areas and housing. It will mean higher living standards and accurate congressional representation. The Census is *everybody's voice in America's future!*

YOU OWE IT TO YOURSELF . . .

Mister Businessman . . . to your business and your community! Put your efforts behind the 1950 United States Census for an even better country to live in . . . the *best* country to do business in!



Like other American business firms, we believe that business has a responsibility to contribute to the public welfare. This advertisement is therefore sponsored by

Technical Publishing Co.

ADVERTISERS

Air Preheater Corp., The 93
Agency—G. M. Basford Company

Allis-Chalmers Mfg. Co. 38, 95
Agency—Compton Advertising Co.

American Blower Corp. 28
Agency—Brooke, Smith, French & Dorrance, Inc.

American Chimney Corp. 128

American Engineering Co. 26-27
Agency—Beatty & Oliver

American Pulverizer Co. ..... *
Agency—Eggers-Rankin Adv. Service

Anthony Company, The ..... *
Agency—Sanger-Funnell, Incorporated

Armstrong Machine Works 4
Agency—Russell T. Gray, Inc.

Babbitt Steam Specialty Co. 131
Agency—Paul L. Kuch Advertising

Babcock & Wilcox Co., The 31
Agency—O. S. Tyson and Company, Inc.

Bailey Meter Company 45
Agency—Fuller & Smith & Ross

Baughman Manufacturing Co., Inc. ..... *
Agency—The Biddle Co.

Beaumont Birch Company ..... *
Agency—The Harris D. McKinney Organization

Belmont Packing & Rubber Co., The 124
Agency—McNevin-Wilson-Daldorf, Inc.

Bersworth Chemical Company 131
Agency—Cory Snow, Inc.

Bets, W. H. & L. D. 91
Agency—The Harris D. McKinney Organization

Biddle Co., James G. ..... *
Agency—The Roland G. E. Ullman Organization

Bird-Archer Co., The 115
Agency—Michel-Cather, Inc.

Builders-Providence, Inc. 118
Agency—Hammond Goff Co.

Cambridge Instrument Co., Inc. ..... *
Agency—E. M. Freystadt Associates, Inc.

Central Scientific Company 120
Agency—Brandt Advertising Company

Chapman Valve Mfg. Co., The ..... Inside Back Cover
Agency—Sutherland-Abbott

Cities Service Oil Co. 40
Agency—Ellington & Company, Inc.

Cochrane Corporation 29
Agency—Willard G. Myers Advertising Agency

Combustion Engineering-Superheater, Inc. 20-21
Agency—G. M. Basford Company

Condenser Service & Engineering Co., Inc. 126

Crane Co. 43
Agency—The Buchen Company

Dart Mfg. Co., E. M. 116
Agency—Sutherland-Abbott

Davis Engineering Corporation ..... *
Agency—Thomas & Delehanty, Inc.

Dearborn Chemical Company 49
Agency—The Fensholt Company

DeLaval Separator Co., The 30
Agency—Donahue & Coe, Inc.

DeLaval Steam Turbine Co. 128
Agency—Geo. H. Gibson Co.

Detroit Stoker Company ..... *
Agency—Witte & Burden

Dowell Incorporated 37
Agency—MacManus, John & Adams, Inc.

Drew & Co., Inc., E. F. 18
Agency—The Aitken-Kynett Co.

Eastern Gas and Fuel Associates 97
Agency-Ketchum, MacLeod & Grove, Inc.

Edward Valves, Inc. 9
Agency—Gebhardt & Brockson, Inc.

Elliott Co. 2-3
Agency—Peterson & Kempner, Inc.

Engineer Co., The 19
Agency—Michel-Cather, Inc.

Erie City Iron Works ..... *
Agency—Davies and McKinney

Ernst Water Column & Gage Co. 132
Agency—Lasky Company

Everlasting Valve Co. ..... *
Agency—Michel-Cather, Inc.

Fluor Corporation, Ltd. 22
Agency—Dozier, Graham, Eastman

Foster Engineering Company ..... *
Agency—Sanger-Funnell, Incorporated

Foster Wheeler Corp. 14-15
Agency—Albert Frank-Guenther Law, Inc.

Garlock Packing Co., The ..... *
Agency—Hutchins Adv. Co., Inc.

General Coal Company ..... *
Agency—The Aitken-Kynett Co.

General Electric Company ..... *
Agency—G. M. Basford Company

Gifford-Wood Co. 119
Agency—O. S. Tyson and Company, Inc.

Golden-Anderson Valve Specialty Co. ..... *
Agency—Walker & Downing

Goodall Rubber Co., Inc. 122
Agency—George C. Taylor

Graver Water Conditioning Co. 121
Agency—Michel-Cather, Inc.

Grinnell Co., Inc. 25
Agency—Horton-Noyes Co.

Griscom-Russell Co., The 103
Agency—Michel-Cather, Inc.

Haering & Co., Inc., D. W. ..... *
Agency—Brandt Advertising Company

Hagan Corporation 13
Agency—Ketchum, MacLeod & Grove, Inc.

Hall Laboratories, Inc. 41
Agency—Ketchum, MacLeod & Grove, Inc.

Hays Corporation, The 114
Agency—Gebhardt & Brockson, Inc.

Hays School of Combustion ..... *
Agency—Kreicker & Meloan, Inc.

International Nickel Co., Inc., The ..... *
Agency—Marschalk & Pratt Co.

Johns-Manville 117
Agency—J. Walter Thompson Company

Kellogg Co., The M. W. ..... *
Agency—Gordon Baird Associates, Inc.

Leeds & Northrup Company 24
Agency—Geare-Marston, Inc.

Link-Belt Co. 109
Agency—Don Proctor Advertising

Lovejoy Flexible Coupling Co. 132
Agency—Symonds, MacKenzie & Company, Inc.

Manning, Maxwell & Moore, Inc. ..... *
Agency—Briggs & Varley, Inc.

Midwest Piping & Supply Co., Inc. ..... *
Agency—Witte & Burden

Milton Roy Company 101
Agency—Walter S. Chittick Company

National Aluminate Corporation 34
Agency—Armstrong Advertising Agency

National Valve & Mfg. Co. 6

Nicholson & Co., W. H. 127
Agency—Wilbur A. Myers

Northern Equipment Company 51
Agency—Davies and McKinney

Pacific Pumps, Inc. ..... *
Agency—The McCarty Company

Panellit, Inc. ..... *
Agency—Armstrong Advertising Agency

Permutit Co., The ..... *
Agency—Cunningham & Walsh, Inc.

Pipe & Tubular Products, Inc. 127

Prat-Daniel Corp. ..... *
Agency—The Harry P. Bridge Company

Proportioneers, Inc. 6
Agency—Hammond-Goff Co.

Republic Flow Meters Co. 32
Agency—Glenn, Jordan, Stoetzel, Inc.

Richardson Scale Co. 123
Agency—O. S. Tyson and Company, Inc.

Rockwell Mfg. Co. 9
Agency—Gebhardt & Brockson, Inc.

Rohm & Haas Company ..... *
Agency—John Falkner Arndt & Company, Inc.

Roto Div. of Elliott Co. 112
Agency—Jos. S. Vogel & Co.

Sarco Company, Inc. ..... *
Agency—W. L. Towne Advertising

Simplex Valve & Meter Co., The ..... *
Agency—Cunningham & Walsh, Inc.

Sinclair Refining Co. 16-17
Agency—Morey, Humm & Johnstone, Inc.

Springfield Boiler Co. 39
Agency—Armstrong Advertising Agency

Standard Oil Co. (Indiana) 23
Agency—McCann-Erickson, Inc.

Stone & Webster Engrg. Corp. ..... *
Agency—Harold Cabot & Co., Inc.

Sun Oil Company 47
Agency—Gray & Rogers

Taylor and Co., W. A. 126
Agency—Emery Advertising Corporation

Terry Steam Turbine Co., The ..... *
Agency—Michel-Cather, Inc.

Texas Co., The ..... Back Cover
Agency—Erwin, Wasey & Co.

Thermix Corp. The ..... *
Agency—The Harry P. Bridge Co.

Treasury Department 125

Troy Engine & Machine Co. 100
Agency—Sanger-Funnel, Incorporated

Tube Turns, Inc. 33
Agency—The Griswold-Eshleman Co.

United States Rubber Company 99
Agency—Fletcher D. Richards, Inc.

United States Steel Corp. ..... *
Agency—Batten, Barton, Durstine & Osborne, Inc.

Universal Atlas Cement Co., (Lumnite Division) ..... *
Agency—Batten, Barton, Durstine & Osborne, Inc.

Vogt Machine Co., Henry 105
Agency—Farson & Huff

Wallace & Tiernan Products, Inc. ..... *
Agency—Branstater-Hammond

Warren Steam Pump Co., Inc. 113
Agency—The Davis Press, Inc.

Western Precipitation Corp. ..... *
Agency—Dozier-Graham-Eastman Advertising

Wheeler Mfg. Co., C. H. 111
Agency—Eugene A. Holland

Wickes Boiler Co., The ..... *
Agency—Price, Hedrick & Tanner, Inc.

Wilson, Inc., Thomas C. ..... *
Agency—Michel-Cather, Inc.

Wing Mfg. Co., L. J. ..... *
Agency—Willard G. Myers Advertising Agency

Worthington Pump & Machinery Corp. 12, 107
Agency—James Thomas Chirurg Company

Wright Chemical Corporation 128
Agency—Schnell & Associates, Inc.

Yarnall-Waring Company 10-11, 52
Agency—Walter S. Chittick Company

Firms whose advertising is not in this issue but is appearing in other issues are marked with an *

New *VERSENE** test kit determines total water hardness in less than *TWO MINUTES*

Now, with this new Versene* water hardness testing kit you can determine the hardness of your own boiler, process or tap water as easy as ABC—in less than 2 minutes. Anyone who can tell red from blue can make this scientific versenate test and be accurate within one grain of hardness per gallon.

Handy, sturdy, pocket-size plastic kit contains 3 vials of chemicals and one combination measuring and mixing vial. More than 50 separate tests can be made, depending on water hardness. Complete instructions. Refills available.

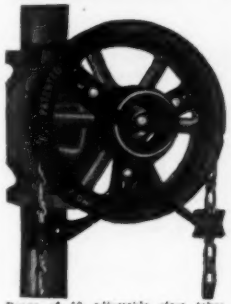
Order The New Versene* Water Hardness Testing Kit today. $3.00 Postpaid. Send Checks or M.O. No. C.O.D.'s. Money Back Guarantee.

We also manufacture and supply di sodium versenate (the di sodium salt of ethylene diamine tetra-acetic acid). This is the reagent used in the Schwarzenbach Method for the determination of water hardness. It is an analytical reagent grade chemical.
50 g. $2.00 100 g. $3.00 500 g. $10.00 Postpaid.

BERSWORTH CHEMICAL COMPANY
FRAMINGHAM, MASSACHUSETTS

*Trade Mark

Overhead Valves EASILY, QUICKLY AND SAFELY controlled from the FLOOR!



Range of 10 adjustable sizes takes care of all valve makes and types; fits valve wheel diameters from 2 to 30 inches.

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

No more climbing up treacherous ladders, on benches, machines or boilers. High-up, inaccessible valves are brought down to earth by the inexpensive BABBITT Adjustable Sprocket Rim with Chain Guide. Here's overhead valve control that is just as positive as direct manual control, and lots easier and safer—*right from the floor!*

The BABBITT Rim fits all valves, with either rising or non-rising stems. It is installed quickly by clamping onto the hand wheel of the valve. *Write today for Catalog Bulletin PG, surprisingly low prices, and name of nearest distributor.*

BABBITT STEAM SPECIALTY COMPANY
2 Babbitt Square, New Bedford, Massachusetts, U. S. A.

POWER PLANT CONSTRUCTION NEWS

(Continued from page 50)

which work will begin in spring. Project will comprise a main one and multi-story building for processing and general production, and auxiliary structures, and is reported to cost close to $1,000,000.

Johnson City, N. Y.—New York State Gas & Electric Corporation, Binghamton, N. Y., has plans for expansion in steam-electric generating station at Johnson City, near Binghamton, with installation of turbine-generator, high-pressure boiler and accessories for increased capacity. Award is being made for structural steel framing and work will begin in spring. No estimate of cost announced.

Grand Forks, N. D.—Minnkota Power Cooperative, Inc., Grand Forks, will begin work soon on superstructure for new steam-electric generating station on local site, with installation to include one 11,500-kw turbine-generator, boiler and auxiliary equipment. Financing for project has been arranged through REA. Ellerbe & Co., First National Bank Bldg., St. Paul, Minn., are consulting engineers.

Anadarko, Okla.—Western Electric Cooperative, Inc., Woodward, Okla., will have plans prepared at once for new steam-electric generating plant in vicinity of Anadarko, with rating of 30,000-kw. Financing in amount of $12,555,000 has been arranged through REA, to provide for construction and extensions in other facilities, including power substations, transmission and distribution lines, etc.

Allentown, Pa.—Pennsylvania Power & Light Co., Ninth and Hamilton St., is arranging an expansion and improvement program during 1950 to cost about $28,000,000, including increase in generating facilities, power substations, transmission lines and other work.

Reading, Pa.—Metropolitan Edison Co., 412 Washington St., Reading, has authorized a 1950 expansion and improvement program to cost approximately $24,000,000, including increased generating facilities, power substations, transmission and distribution lines and miscellaneous work. Gilbert Associates, Inc., same address, is engineer for company.

Retreat, Pa.—General State Authority, 18th and Herr Sts., Harrisburg, Pa., plans extensions and improvements in boiler plant at State Hospital at Retreat, used for central-heating service, including installation of boilers and auxiliary equipment. Cost estimated about $354,000. A. F. Jones is chief engineer for Authority.

Charleston, S. C.—South Carolina Power Co., 141 Meeting St., will carry out extensions in Hagood generating station on Ashley River, with installation of generating unit and auxiliary equipment for increased capacity. Cost estimated about $3,500,000. This will form part of company expansion and improvement program in 1950, which will represent a total investment estimated at $7,220,000.

Sioux Falls, S. D.—East River Electric Power Cooperative, Sioux Falls, has preliminary plans for new steam-electric generating station near Sioux Falls, with turbine-generators, high-pressure boilers and accessory equipment for large capacity. Cost reported about $11,500,000, with switching station, extensions in transmission and distribution lines, and other operating facilities. Financing will be arranged through Federal aid.

Denton, Texas—Water and Light Department has plans for extensions and improvements in municipal oil engine-operated power plant, with installation of additional equipment for increased capacity. Cost reported about $175,000. Wilson & Patterson, Majestic Bldg., Fort Worth, Texas, are consulting engineers.

Snyder, Texas—Barnsdall Oil Co., Neils Esperson Bldg., Houston Texas, refined oils, gasoline, etc., plans steam-generating station and large compressor station at proposed new natural gasoline plant near Snyder. Entire project reported to cost over $2,000,000, with processing and other equipment.

Montpelier, Vt.—Green Mountain Power Corp., Montpelier, has tentative plans for new hydroelectric power plant on Waterbury River (also known as Little River), Washington County, Vt. Details and estimates of cost will be determined soon. Application for permission has been made to Federal Power Commission, Washington, D. C.

Sheboygan, Wis.—Wisconsin Power & Light Co., Sheboygan, will begin work in spring on proposed addition to local Edgewater steam-electric generating plant, about 70 x 120 ft, equivalent to seven stories in height. Installation will include new turbine-generator, high-pressure boiler and accessories, entire development to cost approximately $9,000,000. Sargent & Lundy, 140 South Dearborn St., Chicago, Ill., are consulting engineers.

HOW MUCH DO POWER THROBS COST YOU?

In production loss?
In wear and tear of machinery?
In maintenance?

BIG SAVINGS result from remedying the common source — *poor couplings.*

TYPE "H" for heavy duty with ever-oil smoothness. Special safeguard.

LOVEJOY L-R Flexible Couplings

Most effectually counteract misalignment, vibration, surge, back-lash by simplest construction: resilient, free-floating load cushions suspended between strong metal jaws. Cushions for every duty 1/6 to 2500 h.p. NO SHUT-DOWNS FOR CHANGING. No lubrication.

Get the complete Lovejoy Catalog, and see for yourself!

Quick-finding Selector Charts lead you right to the couplings you need. Write, wire or phone

LOVEJOY FLEXIBLE COUPLING CO.

5084 W. LAKE STREET, CHICAGO 44, ILL.

Also mfrs. of Lovejoy Variable Speed Transmissions and Lovejoy Universal Joints.

ERNST WATER COLUMNS & LIQUID LEVEL GAGES

For Every Application

Split-Gland Water Gages
Mica Shields and Gaskets
Gage Glass Illuminators
Sight Flow Indicators
Safety Plastic Guards
Sight Glass and Discs
Flat Glass Inserts
Tubular Glasses
Try Cocks, Etc.

WRITE FOR BULLETIN

Ernst Water Column & Gage Co.
LIVINGSTON, N. J.

Fig. 83

Be Well Informed About ATOMICS

ATOMICS is published bi-monthly for engineers. The timely articles appearing in each issue are essentially practical in nature, written for the average engineer. A. W. Kramer, the editor of ATOMICS, has been a pioneer in interpreting and translating the complex, highly technical material issuing from the laboratory into language every engineer can understand. ATOMICS is the first regularly published journal of its kind. The issues sparkle with engineering data, news of atomic power, articles of timely interest to those concerned with industrial process control, practical material for men interested in the technical and engineering aspects of nuclear reactions.

ATOMICS - 53 W. Jackson Blvd. - Chicago 4, Ill.

REDUCE PIPE LINE MAINTENANCE COSTS with CHAPMAN

TILTING DISC

Check Valves

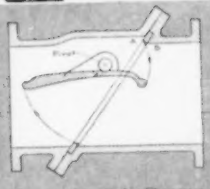
Because of their unique design, Chapman Tilting Disc Check Valves *close without slamming*. There is no water-hammer . . . no vibration of pipe lines or adjacent structure. Nor any danger of opening up pipe joints or rupturing pipe lines. All mighty important reasons why maintenance costs are bound to go down when you standardize on this valve with the cushioned closing.

Yet that's only part of the story. Chapman Check Valves also reduce head losses 65% to 85% over conventional type check valves. And, when installed on pump discharge lines, they not only make possible increased pipe-line capacity but also effect substantial power savings.

Why not send for bulletin with engineering data *today*?

THE CHAPMAN VALVE MANUFACTURING COMPANY

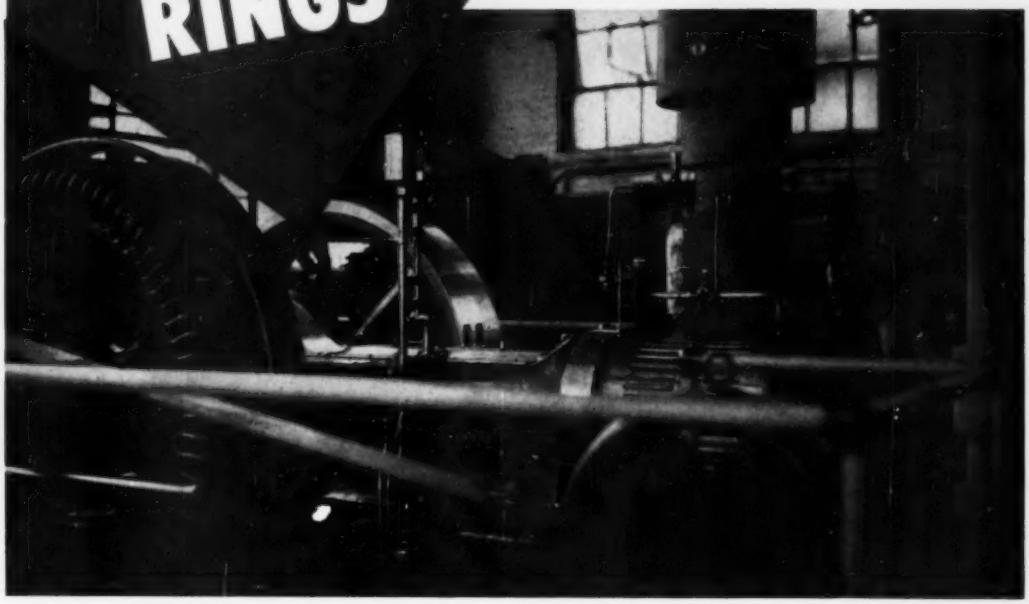
INDIAN ORCHARD, MASSACHUSETTS



Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

ASSURE STEAM-TIGHT RINGS

Engines give full power, greater economy with Texaco steam cylinder oils



Texaco makes *a complete line* of steam cylinder oils. This means you can get the one you need to keep engines running smoothly . . . regardless of whether they are oldtimers or mere youngsters in service.

Aside from your special requirements, you will find that all Texaco steam cylinder oils have these basic advantages: they atomize thoroughly and properly . . . cling to cylinder walls to guard against wear and to keep rings steam-tight . . . stop "groans" and reduce maintenance costs.

Let a Texaco Lubrication Engineer recommend the proper Texaco steam cylinder oils to assure best results in your engines. Just call the nearest of the more than 2,000 Texaco Wholesale Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Steam Cylinder Oils

FOR EVERY OPERATING CONDITION

TUNE IN . . . TEXACO STAR THEATER presents MILTON BERLE on television every Tuesday night. Consult your local newspaper for time and station